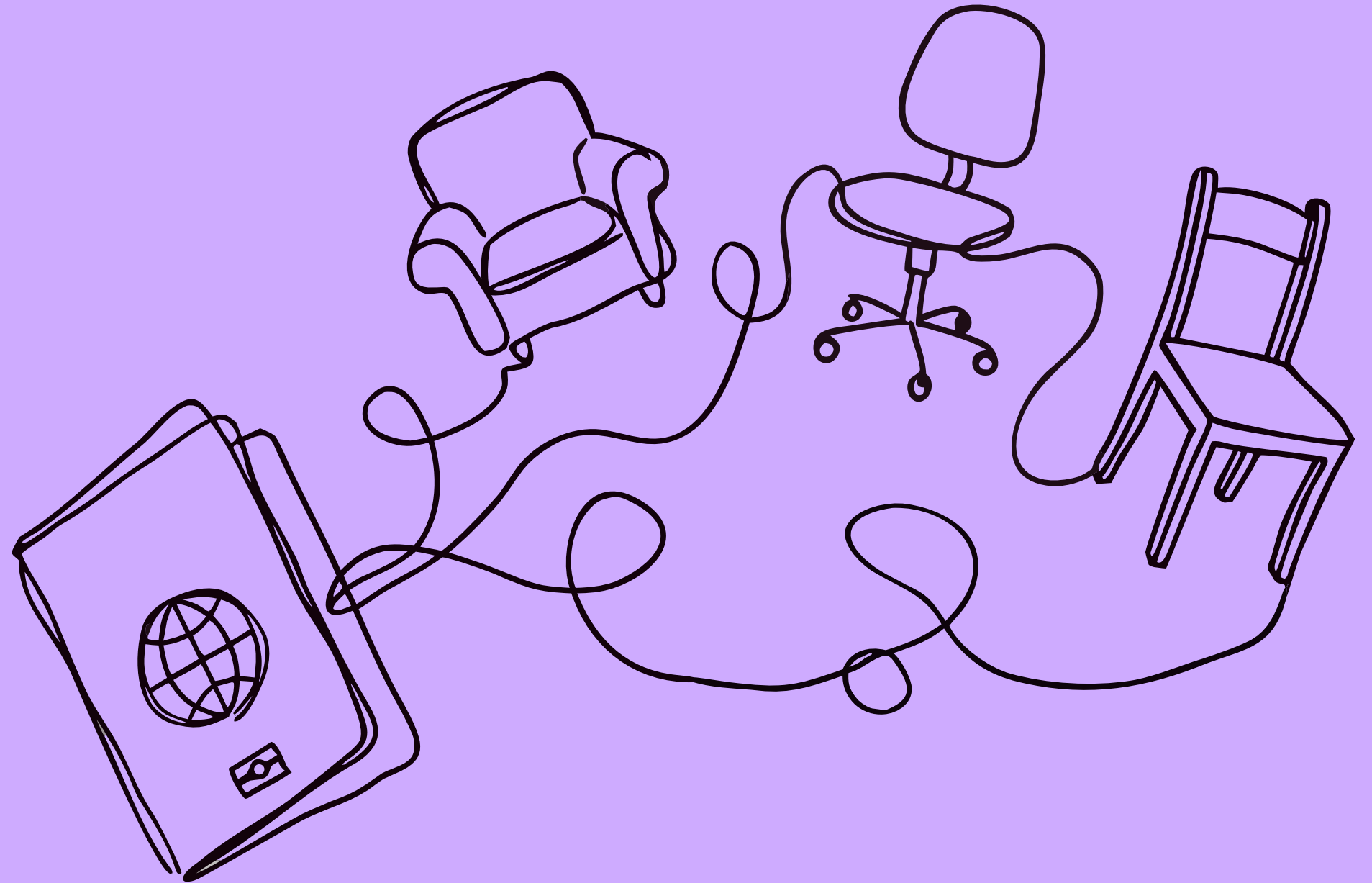


Atlas of Circular Textiles

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Chapter 1



About the CEO Project

The Circular Economy Office (CEO) project is a transnational collaboration under Interreg North Sea Region (2023–2026), bringing together 13 organisations from six countries to drive the shift from a linear to a circular office furniture market.



Each region ran a pilot with its own focus. Flanders worked on circular value chain integration, including material passport systems for office furniture. Utrecht tested circular workplace concepts and internal reuse models across two office floors. France explored circular production processes and conditions for new business models. Copenhagen developed a reuse platform combining a digital exchange with a physical furniture warehouse. Malmö built an internal reuse infrastructure within the municipality. Northern Germany fitted out the new HiiCCE office as a circular office showcase for the region.

The Netherlands	City of Utrecht · Oost NL · Enschede Textielstad
Belgium (Flanders)	Circular Flanders · WOOD.BE · Kringwinkel Antwerpen · ONBETAALBAAR
France	Communauté de Communes Pévèle Carémbault · Institut Technologique Forêt Cellulose Bois-construction Ameublement (FCBA)
Denmark	Municipality of Copenhagen
Sweden	City of Malmö
Germany	HiiCCE Hamburg Institute for Innovation, Climate Protection and Circular Economy GmbH · INDEED Innovation

The East Netherlands Pilot

Circular Textiles in Offices

This guide is one of the results of the East Netherlands pilot, led by Oost NL and Enschede Textielstad (ETS).

Oost NL is the regional development organisation for Gelderland and Overijssel, working on innovation, sustainability, and economic transition in the eastern Netherlands. In the CEO project, Oost NL coordinated the pilot and connected ETS to procurement actors and furniture manufacturers in the region.

Enschede Textielstad is a weaving mill based in Enschede, developing and producing woven textiles for various applications, with circularity and sustainability as guiding principles.

The East Netherlands pilot focused on closing the loop on textiles in office furniture.

This guide translates the knowledge built during the pilot into practical guidance for the people who buy, specify, and design with textile in office environments.

The work covered three areas:

Material innovation

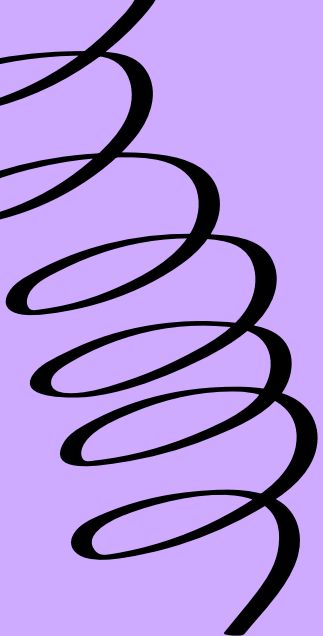
Developing textile samples from natural and recycled materials, including Dutch wool, hemp, and cotton combined with post-consumer recycled fibres.

Circular production

Testing production-on-demand models and digital prototyping to reduce overproduction and material waste.

Circular business models

Exploring furniture-as-a-service, design for recycling, and design for disassembly in office textiles.



Objective of this guide

This guide helps you make informed decisions about textile products in office environments.

It is written for professionals with different backgrounds: procurement officers and municipalities working on sustainable purchasing, manufacturers specifying materials for office furniture, policy actors developing standards or criteria around circular textiles, and designers and brands making material choices for contract interiors. What these groups have in common is the need to evaluate textiles and their circularity without being textile experts.

No prior knowledge of textiles is necessary for reading and understanding this guide. We will navigate you through all the information you need.

What this guide does and what it doesn't

The guide gives you a framework for understanding circular textile options, not a ranking of materials. We explain what the technical parameters on a specification sheet actually mean, where sustainability claims hold up and where they don't, and why some things that sound straightforward (terminology like "recycled", "natural", "certified") are more complicated in practice.

If a technology is promising in terms of circularity and sustainability, but not yet applicable on an industrial scale, we will say so. We believe in honesty when it comes to circularity; boasting and greenwashing don't help the circular transition.

The focus is on woven textile for office environments: upholstery, curtains, acoustic panels. The main focus lies on upholstery fabrics, since that's the most technically challenging of them all, and the material ETS focused on in the CEO pilot. Other materials commonly used in furniture, like foam, steel and wood, appear briefly where they help clarify how textile performs or how end-of-life scenarios work.

Readers with questions about furniture design principles, circular business models, or EU compliance requirements will find dedicated guides for those topics in chapter 17.

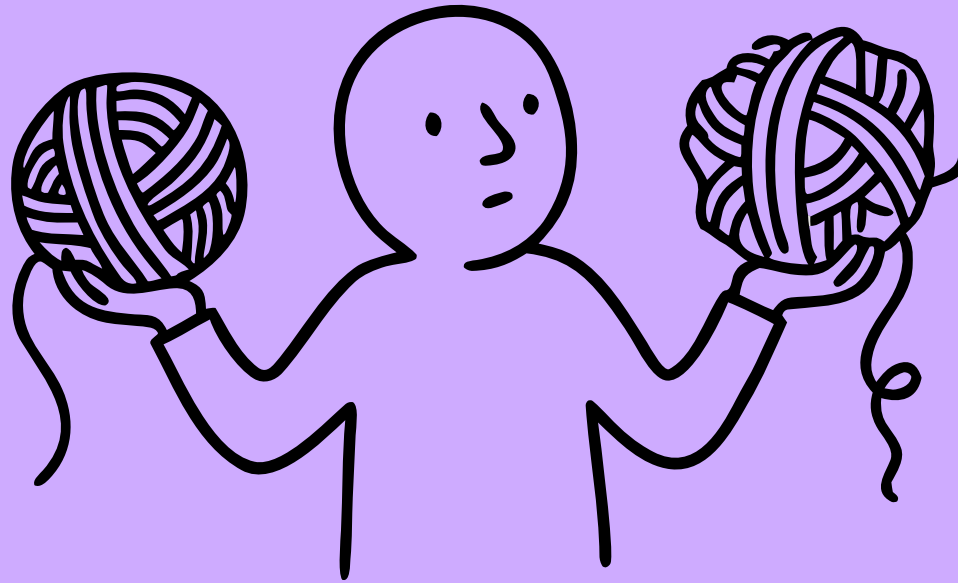
How to use this guide

The guide has two parts:

Part 1: the Compass, is for readers who want a fast orientation. Four short chapters cover who this guide is for, how to find what is relevant for your situation, five questions to ask before you order, and five greenwash signals to recognise.

Part 2: the Atlas, is the knowledge behind the Compass. Each chapter stands on its own. You can read it front to back or go directly to the topic you need.

Chapter 2



Where do you start? A guide per situation

You don't need to read this guide from front to back. This chapter helps you find what is relevant for your situation. Choose your application, read the questions that matter most, and follow the references to the atlas chapters that give you the answers.

The Compass

Upholstery Fabrics

Upholstery is the most technically demanding application in this guide and the one with the most at stake for circularity. Fibre choice, weave structure, finishing and end-of-life options are all closely connected. If you are specifying upholstery fabric, start here.

Five questions to ask first

What is the expected intensity of use: light office seating, a busy meeting room, or a hightraffic public zone?

What technical performance requirements apply? Such as abrasion resistance (Martindale), pilling, or colourfastness?

Are there fire classification requirements in the specification or tender?

What happens to the fabric at the end of its life? Is there a take-back route, and does the material composition support it?

Are specific certifications required or preferred, and do you know what those certifications actually cover?

Relevant chapters

Chapter 5 (How to read a fabric) · Chapter 6 (Fibres) · Chapter 8 (Finishing) · Chapter 9 (Certifications) · Chapter 10 (EU regulations) · Chapter 14 (Applications in practice)

Five questions to ask first

Is the fabric exposed to direct sunlight? If so: for how many hours a day?

Are there fire classification requirements in the specification or tender?

Will the fabric be machine washed regularly, or dry cleaned?

What technical performance requirements apply? For example light fastness or dimensional stability after washing?

Are specific certifications required or preferred, and do you know what those certifications actually cover?

Relevant chapters

Chapter 6 (Fibres) · Chapter 8 (Finishing) · Chapter 9 (Certifications) · Chapter 10 (EU regulations) · Chapter 14 (Applications in practice)

Curtains

Curtains are under less mechanical stress than upholstery, but light exposure and fire behaviour are often the deciding factors. The finishing layer matters more here than many buyers expect.

Acoustic Panels

Acoustic panels often fall under the same specification as upholstery and curtains. The textile here is typically stretched over a frame rather than sewn or bonded, which affects both performance and end-of-life options.

Five questions to ask first

How is the fabric attached to the panel? Stretched over a frame, or bonded?

What technical performance requirements apply, is a fire classification or acoustic absorption class necessary?

Are there requirements for light fastness or colour consistency across panels?

What is the expected service life, and is replacement of the textile cover planned separately from the frame?

Are specific certifications required or preferred, and do you know what those certifications actually cover?

Relevant chapters

Chapter 5 (How to read a fabric) · Chapter 6 (Fibres) · Chapter 9 (Certifications) · Chapter 10 (EU regulations) · Chapter 11 (Circularity beyond recycling) · Chapter 14 (Applications in practice)

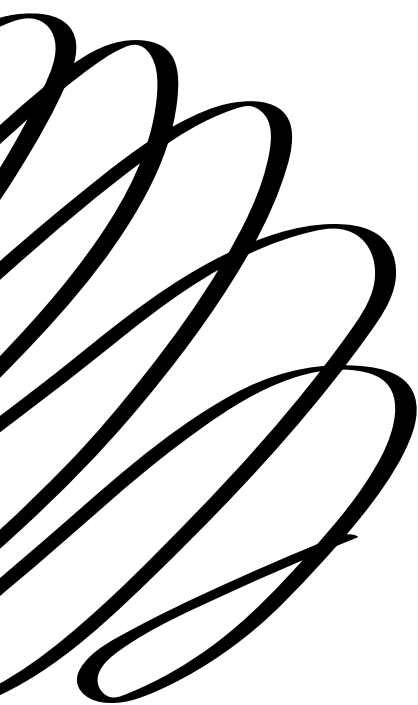
Chapter 3



**What
matters
to you?
Set your
priorities**

Choosing circular textile involves compromises. A fabric that scores well on fibre composition may fall short on finishing. A certified product may not have a viable end-of-life route. Before you dive into the atlas, it helps to know which themes matter most in your situation.

The table below lists the main topics this guide covers. For each one, there is a short explanation of why it is relevant for circularity. Use the priority column to note what is most important for your purchasing context.



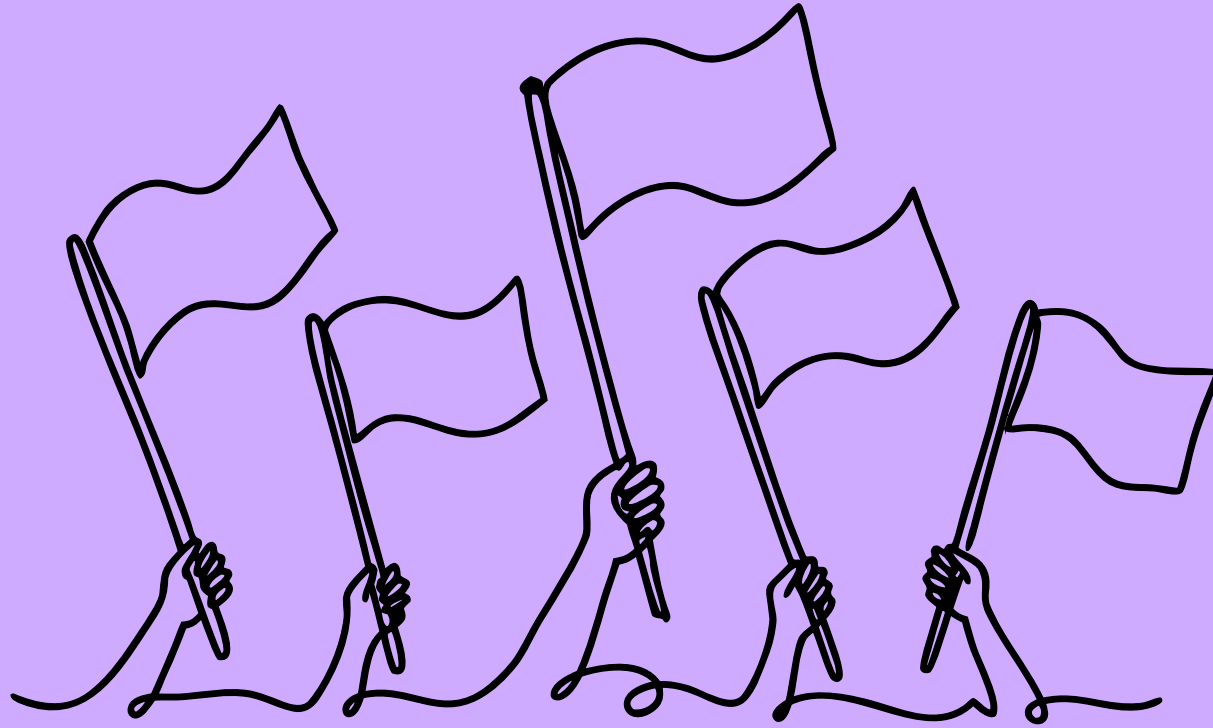
How to use this table

Fill in your priority for each theme: High, Medium or Low. There are no right or wrong answers. Your priorities will depend on your organisation, your application and the requirements you are working with.

Once you have filled in your priorities, use the chapter references to go directly to the topics that matter most to you.

Theme	Why it matters for circularity	Your priority
How to read a fabric (Ch. 5)	The construction of a fabric (warp, weft, weave structure, weight) determines durability and affects which end-of-life routes are possible.	
Fibre composition (Ch. 6)	The fibres a fabric is made from determine its environmental footprint, its performance in use, and whether it can be recycled at the end of its life.	
What is not yet possible (Ch. 7)	Some circular solutions exist in theory but not yet at industrial scale. Knowing the current limits helps you ask better questions and avoid greenwashing claims.	
Finishing (Ch. 8)	Coatings, dyes and treatments affect durability, health and recyclability, sometimes more than the fibre itself. Asustainable fibre with a problematic finish is still a problem.	
Certifications (Ch. 9)	Labels and certifications vary widely in what they cover and how they are verified. Understanding what a certificate actually means is essential for making it a useful selection criterion.	
EU regulations (Ch. 10)	Recycling is one end-of-life option, but longevity, reparability and design for disassembly often have a greater impact.	
Production context (Ch. 12)	Where and how a fabric is produced affects its carbon footprint, social conditions and the feasibility of take-back schemes.	
Use and maintenance (Ch. 13)	How a fabric is washed, dried and maintained over its lifetime can determine more of its environmental impact than the material itself.	
Social aspects (Ch. 14)	Labour conditions, living wages and health risks in production and finishing are part of a complete picture of sustainability.	

Chapter 4



**Five
greenwash
signals to
recognise**

Sustainability claims in textile are common. Genuine, evidence-backed ones are rarer. The signals below are not proof of greenwashing; they are patterns worth examining more closely. Each one points to a claim that sounds clear but often isn't.

What to ask:

What is the full lifecycle of this fabric, from raw material to end of life?

"100% natural"

Natural fibres have real advantages in performance, feel and in some cases end-of-life. But "natural" is not the same as "sustainable". The environmental impact of a natural fibre depends on how it is grown or raised, how it is processed, what chemicals are used in finishing, and what happens to the fabric at the end of its life. A natural fibre with a heavy finishing treatment or no viable recycling route is not automatically a better choice than a well-designed synthetic alternative.

What to ask:

What percentage is recycled, what type, and which part of the fabric does it apply to?

"Recycled"

Recycled content is a step forward, but the claim needs context. What percentage is recycled? Is it pre-consumer waste (offcuts from production) or post-consumer waste (collected after use)? Does the recycled content apply to the warp, the weft, or both? A fabric described as "recycled" may contain a small percentage of recycled material in only one of its components.

"Certified"

What to ask:

What exactly does this certification cover: which steps in the production process, and which properties of the final product?

A certification is only as meaningful as what it covers. Some labels certify the fibre at source. Others cover the dyeing process. Others verify the finished product. A fabric can carry a respected label and still have been treated with problematic chemicals in a finishing step that falls outside the certification scope.

What to ask:

Under what conditions is this fabric biodegradable, and what happens to the finishing treatments during breakdown?

"Biodegradable"

Biodegradability is often tested under controlled laboratory conditions that have little in common with what actually happens at end of life. A fabric that biodegrades in a lab setting may not do so in a landfill, in a composting facility, or in the environment. The claim also says nothing about what is released during breakdown, or whether the finishing treatments affect the process.

What to ask:

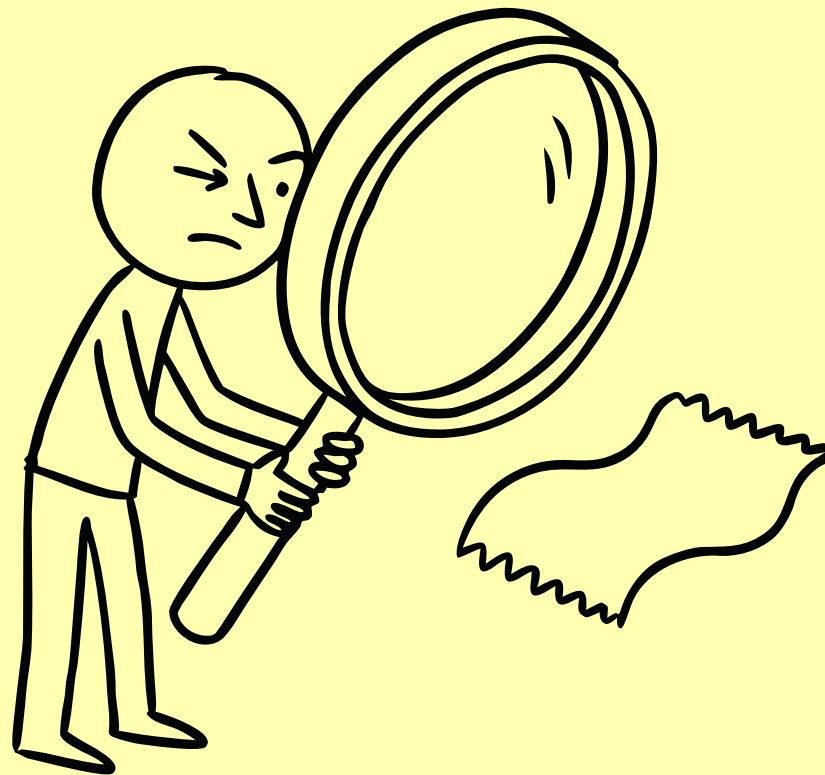
Is carbon neutrality achieved through emission reductions in the production process itself, or through offsets? And what standard are the offsets verified against?

"Carbon neutral"

Carbon neutral claims are frequently based on offsets rather than actual emission reductions. Purchasing carbon credits does not reduce the emissions from spinning, weaving, dyeing or transporting the fabric. It compensates for them elsewhere, and the quality and permanence of those offsets varies considerably.

The atlas chapters on fibres (Ch. 6), finishing (Ch. 8) and certifications (Ch. 9) give you the background to evaluate these claims in more detail.

Chapter 5



This guide focuses on woven fabrics. That is a deliberate choice: Enschede Textielstad is a weaving mill, and the knowledge in this guide is grounded in that expertise. Knitted fabrics and non-wovens exist and are used in some office applications, but they follow different construction logic and are therefore not covered here. In this chapter we explain how a woven fabric is developed, what the numbers on a specification sheet actually mean, and what construction choices might tell you about durability and end-of-life options.

How to read a fabric

The two axes: warp and weft

What to ask:

What is the fibre composition of the warp, and what is the fibre composition of the weft?

A woven fabric is made from two sets of threads that cross each other at a 90 degree angle. The warp runs along the length of the fabric and is held under tension on the loom throughout the weaving process. The weft is woven across the warp, thread by thread, without significant tension.

Warp and weft yarns have different requirements. Warp yarns need to be strong, smooth and tightly twisted to withstand the mechanical stress of weaving. Weft yarns can be softer and more loosely twisted, which contributes to the texture and feel of the fabric surface.

In practice, warp and weft are often made from different materials. A fabric may have a polyester warp for structural strength and a wool weft for surface quality and appearance. This means that a fabric cannot always be evaluated on fibre content alone: you need to know which fibre is where.

Most specification sheets show a combined fibre percentage, for example 70% wool / 30% polyester, without specifying which component is warp and which is weft. That information is available from the supplier, but you usually need to ask for it specifically.

Fabrics are made from yarn, and yarn comes in two fundamental types.

Spun yarn is made by twisting together short fibres (staple fibres). The result is a slightly hairy yarn with a soft, natural feel. Wool, cotton, linen and most recycled fibres are processed as spun yarns. Spun yarns can pill over time as loose fibres work their way to the surface, but they tend to have good colour depth and a warm appearance.

The way staple fibres are spun into yarn affects the quality and character of the result. The main spinning methods are:

Ring spinning: a method suited to longer staple fibres, in which fibres are drawn out and twisted continuously around a rotating ring. The process A fibre alignment. For virgin, high-quality long-staple fibres, ring-spun yarns are considered the benchmark for quality in woven upholstery.

Open-end spinning: a method for shorter staple fibres, in which fibres are fed into a rotor and twisted together through centrifugal force rather than a continuous draw. This produces a coarser, slightly more irregular yarn than ring spinning. Commonly used for cotton and recycled fibres, where staple length is shorter and consistency varies.

Vortex spinning: an air-based method in which fibres are twisted by an air vortex around a hollow spindle. It produces yarns with a hard-wearing surface and low pilling tendency, but is also used for textured and fancy yarns such as bouclé, where the air flow creates irregular loops and effects.

Wet spinning: used for natural protein and cellulosic fibres such as linen and viscose, where the fibre material is dissolved or conditioned in water before being extruded and spun. The liquid medium allows these fibres to be drawn into yarn in a way that dry spinning cannot achieve.

Synthetic filament fibres such as polyester and nylon are also produced through a form of extrusion: the polymer is melted or dissolved and forced through fine spinnerets to create continuous filaments. This is technically a form of wet or dry spinning, but distinct from staple fibre spinning methods.

The spinning method is not always stated on a specification sheet, but it influences yarn strength, surface character and how the fabric behaves over time.

Filament yarn is made from continuous synthetic fibres, typically polyester or nylon. The result is a smooth, strong yarn with a very consistent surface. Filament yarns are more resistant to pilling and abrasion, but can be prone to snagging. Fabrics made from filament yarn tend to have a smoother, more lustrous appearance than spun yarn fabrics. This is a visual quality that is often not preferred in contract upholstery, where a more matte, textile-like surface is typical.

For circularity, the yarn type affects what happens at end of life. Spun yarns from a single fibre type can be mechanically recycled if the fibre quality is sufficient. Filament yarns from thermoplastics can in principle be melted and reprocessed, provided they are not mixed with other materials.

Yarns: spun and filament



Weave Structures

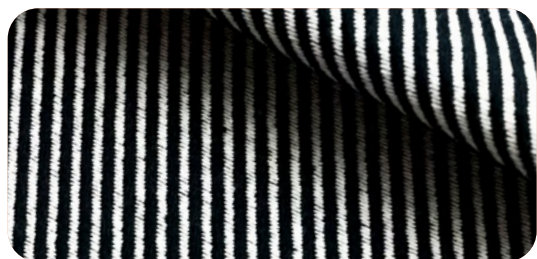
The pattern in which warp and weft are interlaced determines the structure of a fabric. Four weave types form the basis of almost all woven upholstery: plain weave, basket weave, twill and satin. Each has distinct technical properties that affect durability, drape and surface character.



Plain weave is the simplest and most stable weaving structure: each weft thread passes alternately over and under each single warp thread. This creates the maximum number of interlacing points per surface area. The result is a firm, stable fabric with good dimensional stability. Plain weave fabrics are resistant to distortion. The downside is limited flexibility: plain weave fabrics are less drapey than other constructions and because of the many interlacing points it is more difficult to achieve a high weft density whilst weaving.



Basket weave is a variant of plain weave in which multiple warp and weft threads are grouped and interlaced together as a unit. The grouped threads create a slightly larger interlacing square, which softens the rigidity of the plain weave without significantly reducing stability. Basket weave, often referred to as panama weave, has a characteristic basket-like surface texture. It is well suited to upholstery where a more textured appearance is desired with plain-weave structural properties.



Twill creates a diagonal pattern by passing the weft over two or more warp threads before going under one. Fewer interlacing points give the fabric more flexibility and drape than a plain weave. The diagonal structure also makes twill more forgiving under stress: forces are distributed along the diagonal rather than concentrated at fixed interlacing points. For upholstery, twill constructions can achieve good abrasion resistance despite the lower interlacing density, particularly when yarn quality is high.



Satin weave uses a system of long floats: the weft passes over at least four warp threads before interlacing, minimising the number of binding points. The long floats align on the surface, creating a smooth, lustrous appearance with a characteristic sheen. Satin fabrics feel soft and have good drape. The smooth surface works particularly well in jacquard constructions, where pattern detail and gloss combine to strong visual effect.

A possible downside lies in abrasion resistance: the longer exposed floats are more vulnerable to snagging than tighter weave structures. For very high-traffic applications this is a relevant consideration when specifying. Test in standard office environments, and particularly where surface quality and aesthetics are a priority, satin-derived constructions are a well-established choice.

One construction factor that cuts across all four binding types is float length: the number of warp or weft threads a yarn passes over before interlacing. Longer floats create a smoother surface but are more vulnerable to abrasion and snagging, as the unsupported thread can catch and break. For contract upholstery, keeping floats to a maximum of three to four threads is a practical guideline for maintaining durability.

A higher abrasion score does not follow automatically from a particular weave structure. The relationship between structure, yarn and durability is not linear. A tightly woven twill can outperform a loosely woven plain weave. The numbers on a specification sheet are the result of the whole construction, not of one variable.



Well

Design systems: dobby and jacquard

The two main systems for creating patterned woven fabrics are the dobby and the jacquard. Both are mechanisms that control which warp threads are raised at each step of the weaving process, but they work in different ways and offer different design possibilities.



A dobby loom controls warp threads in groups called shafts. All threads connected to the same shaft move together. This makes dobby weaving efficient for geometric patterns built from repeating sequences, but the design is constrained by the number of shafts available, typically up to sixteen or twenty-four on most commercial looms. Dobby is well suited to structured patterns, stripes, small geometric motifs and textured effects.



A jacquard mechanism controls each individual warp thread independently. The design is no longer limited by the number of shafts. Patterns of any complexity, be it figurative, organic, highly detailed, are achievable within the width of the loom. Jacquard looms were originally controlled by punched cards, each row of holes instructing the mechanism which threads to raise. Modern jacquard looms are computer-controlled, with the pattern encoded digitally.

Using jacquard design software, a weaver can simulate how a pattern will look in specific yarns and constructions before the loom is set up and any yarn is woven. Colour combinations, binding variations and scale adjustments can be tested on screen. Only when the design is close to its final form does a physical sample need to be woven. This reduces the material consumption of the development process and shortens iteration cycles considerably.

Weaving is not simply pushing a button and waiting until a fabric rolls out of the loom; many variables influence each other both during and after the weaving process. The specification numbers on a datasheet describe the outcome of a series of construction decisions. Understanding those decisions makes the numbers easier to interpret and the conversation with a weaver more productive.

A weaver developing a fabric for a specific application can adjust the following variables, each of which affects the durability, appearance and end-of-life behaviour of the final product:

Yarn selection: the properties of the warp and weft yarns determine much of what the fabric can and cannot achieve. Relevant yarn characteristics include spinning technique, fibre length, fibre quality, linear density (count), twist level, tensile strength, elongation, hairiness and regularity. Each of these affects how the yarn performs under mechanical stress, tension and speed in weaving and how the fabric behaves during use.

Warp-to-weft ratio: the proportion of warp and weft in the finished fabric influences surface character, drape and the relative contribution of each yarn type to the overall performance.

Fibre composition of warp and weft: different fibres can be used in warp and weft. A construction with a strong synthetic warp and a natural-fibre weft can combine the mechanical durability of the synthetic with the surface quality and appearance of the natural fibre, but a wrong fibre combination can also result in pilling, poor tearing resistance and other negative properties.

Weaving pattern: the chosen weaving pattern, specifically the amount of floats (weft crossing warp threads and vice versa), determines structural density and float length. A binding with shorter floats produces a more locked, abrasion-resistant construction; longer floats produce a smoother surface at the cost of durability.

Density: the number of warp and weft threads per centimetre determines how tightly the fabric is constructed. Higher density generally improves abrasion resistance and dimensional stability. But balance is key: with a coarser yarn you might want to lower the number of threads per centimetre in the warp in order to be able to insert more weft yarns. A balanced cloth with similar yarn counts in warp and weft and similar warp and weft densities is what a weaver strives for in high-performance fabrics.

Cloth thickness: a result of yarn count, density and construction, cloth thickness contributes to the tactile quality and mechanical performance of the finished fabric.

Finishing: the steps applied after weaving, whether mechanical

or chemical, modify the surface and performance properties of the base construction. These are discussed in Chapter 8.

No single variable determines performance in isolation. The specification numbers on a datasheet are the result of the whole construction, which is why two fabrics with the same stated fibre composition can perform very differently.

People often underestimate the impact that the weaving process can have on the quality of a cloth, both in a positive and in a negative sense.

What a weaver controls

What to ask:

Which of these variables was adjusted to meet the performance requirements for this application?

The numbers on a specification sheet

Suppliers of contract upholstery fabric typically provide a technical datasheet with each product. These sheets list a standard set of performance results: weight, abrasion resistance, pilling, light fastness, and in some cases additional tests relevant to the application. The numbers are useful, but they require context. Industry standards set minimum thresholds for different use categories, and the same score can mean something different depending on how the test was conducted and what the fabric is expected to do. A weaver developing a fabric for a specific application can influence these outcomes through construction choices such as yarn selection, density, weave structure and finishing all affect what the test will measure.

This section explains what the main tests measure, how they are conducted, and what the results do and do not tell you.

Weight (g/m²)

Weight (g/m²)

Fabric weight reflects the combined mass of the yarns and any finishing layers. It is an indicator of material volume, not of quality. For office upholstery in contract environments, weights typically range from 280 to 450 g/m², with heavier fabrics generally used for high-traffic applications. Weight alone does not tell you whether a fabric will wear well. A light fabric with a dense, well-constructed weave can outperform a heavier fabric with a loose construction.

Pilling (ISO 12945-2)

Pilling measures how a fabric's surface holds up under repeated friction over time. As loose fibres work their way to the surface, they can form small fibre balls also known as pills that affect the appearance of the fabric without necessarily affecting its structural integrity.

Results are reported on a scale of 1 to 5:

- 5: no pilling — the surface is unchanged
- 4: slight pilling — barely visible change
- 3: moderate pilling — noticeable but limited
- 2: significant pilling — clearly visible, affects appearance
- 1: severe pilling — heavy surface change

For contract upholstery, a minimum of grade 3 to 4 is typically required. Spun yarns from natural fibres tend to be more prone to pilling than filament yarns; the fibre length, twist and finishing all influence the result.

Light fastness (ISO 105-B02)

Light fastness measures how well the colour of a fabric holds up under exposure to artificial light over time. The test uses a xenon arc lamp to simulate daylight conditions.

Results are reported on a scale of 1 to 8 (the blue wool scale):

- 8: excellent light fastness — virtually no colour change
- 6 to 7: very good — minimal fading
- 4 to 5: good — moderate fading, acceptable for most interior applications
- 3: moderate — noticeable fading, typically not suitable for contract use
- 1 to 2: poor — significant fading

For office upholstery and curtains, a minimum of grade 5 is generally expected. For applications with direct sun exposure, grade 6 or higher is advisable.

What to ask:

What Martindale value does this fabric achieve, and at what test pressure? And what value is actually required for the intended application?

Martindale (ISO 12947-2)

The Martindale test measures how many abrasion cycles a fabric withstands before the surface breaks down. It is the standard abrasion test for upholstery fabric in Europe.

The test works by pressing a fabric sample against a standard wool worsted abradant in a figure-of-eight motion under a defined load. For upholstery, the standard load is 12 kPa. The test is stopped when two threads break.

The established classification for office contract upholstery is 30,000 to 40,000 cycles for standard use, and 40,000 or more for high-traffic environments. Historically, 20,000 cycles was considered adequate for commercial low-traffic applications in home environments.

Over time, specification requirements have shifted upward. Synthetic fabrics made from nylon or polyester routinely achieve 100,000 cycles or more. The EU Green Public Procurement criteria for furniture set 100,000 cycles as an award criterion (Donatello et al., 2017). This threshold systematically disadvantages natural-fibre fabrics, which typically score lower not because they fail in use, but because the test rewards the mechanical properties of synthetic materials.

The Association for Contract Textiles has formally noted that specifiers are increasingly demanding higher abrasion numbers beyond what real-world use requires, and that fabric failures in practice are far more commonly caused by inappropriate cleaning or maintenance than by low abrasion scores (ACT, n.d.).

There is also a methodological nuance: the Martindale test uses a wool worsted abradant. This means synthetic fabrics are tested against wool, while wool fabrics are also tested against wool. The test does not use a neutral abradant, which affects how results compare across fibre types.

ETS in practice. How much abrasion resistance is actually needed?

The question of over-specification has a practical side. In tests conducted by ETS on upholstery fabrics removed from chairs at the end of their service life, fabrics that originally carried a Martindale score of over 100,000 cycles still tested at between 30,000 and 60,000 cycles after years of use in office and home environments.

This raises the question: if a fabric starts above 100,000 and ends its useful life at 30,000 to 60,000, was the original 100,000 requirement necessary?

Specifying for actual performance rather than for a number that exceeds what use requires is in our opinion very important to enable the transition towards a circular economy. By asking for realistic requirements a broader range of fabrics becomes viable, including natural and/or recycled fabrics with a lower initial score that still outlast the typical replacement cycle by a significant margin.

Further specifications commonly found on datasheets

Colourfastness to rubbing (ISO 105-X12) measures how much colour a fabric transfers to another surface under dry and wet friction. Results use the same 1–5 scale as pilling. Minimum values typically required: grade 4 dry, grade 3 wet.

Dimensional stability measures how much a fabric shrinks or stretches after exposure to water or heat. Reported as a percentage change in warp and weft direction. Relevant for fabrics that may be cleaned with water-based products.

Seam slippage measures how far the yarns in a fabric can be pushed through a seam under load, leaving a gap between seam and fabric. A low slippage value indicates that the fabric construction holds its position at the seam, which matters for tightly upholstered applications.

Tear strength measures the tensile force, in Newtons, that a fabric can withstand before it tears. Relevant for fabrics used in applications with mechanical strain.

Fibre composition and end-of-life

The fibre composition of a fabric determines which end-of-life routes are available.

Mono-material fabrics (100% polyester, 100% wool, 100% cotton) are in principle recyclable on existing mechanical routes, provided the fibre quality and the fabric structure are suitable for retaining sufficient fiber length and the fabric has not been treated with coatings that interfere with the process.

Blended fabrics are more nuanced than is sometimes suggested. Mechanical recycling of blended fabrics is possible if the fibre quality is good. What blends do require is more careful assessment: the composition needs to be known, the fibres need to be compatible with the recycling process, and the resulting recycled material may be suitable for different end uses than the original fabric. Mono-materials remain preferable for circularity because they are simpler to process.

Elastane is the exception. Elastane cannot be separated from other fibres mechanically, and it often melts at the temperatures used in mechanical recycling drums, clogging them and causing downtime in the recycling process.

Backing materials have a negative effect on recyclability that is often overlooked. Fabrics with a firebacking, dacron layer, or any laminated or bonded construction are considerably harder to recycle mechanically. The large difference in fibre length and thickness between the backing and the main fabric disrupts the recycling process. A backed fabric is by definition more difficult to recycle than an unbacked one with the same face composition.

What to ask:

What is the exact fibre composition, including any backing or bonded layers? And is there a take-back or recycling route that works with this specific construction?

Chapter 6



No fibre has only advantages. The environmental impact of a textile product is distributed across the entire value chain: agriculture or raw material extraction, spinning and weaving, finishing, use and end of life. What matters is the impact of this specific fibre, at this specific point in the chain and for this specific application.

This chapter covers five fibre groups: plant-based, animal-based, regenerated cellulosic, fossil-based synthetic, and recycled. These categories overlap in practice: a fabric may combine a natural fibre in the weft with a recycled synthetic in the warp, or use a blended yarn of two different origins. Reading a fabric well means reading its construction and understanding what each component brings.

A note that applies across all five groups: the environmental impact of a fibre does not end at the farm gate or the spinning mill. Dyeing, finishing and other wet processing steps add a further load of water, chemicals and energy to any fibre type. These steps are covered in Chapter 8. The profiles below focus on the fibre itself and its primary production chain.

Raw materials — five fibre groups



Group 1:

Plant-based fibres

Fibres: cotton, linen, hemp

Plant-based fibres are grown, and most of their environmental impact is concentrated in the agricultural phase: land use, water consumption, and the use of pesticides and fertilisers.

Cotton is the most widely used plant fibre in textiles globally. Conventional cotton cultivation is water-intensive: estimates put the water footprint of a kilogram of cotton at around 10,000 litres, including rainfall and irrigation (Mekonnen & Hoekstra, 2011). It also accounts for a disproportionate share of global insecticide use relative to the area it occupies. Organic cotton reduces the chemical burden but remains water-intensive. An emerging approach is regenerative cotton, grown using farming practices that aim to improve soil health, increase biodiversity and sequester carbon. This is a developing field, and Textile Exchange maintains a Regenerative Agriculture standard for it (Textile Exchange, 2023).

Linen (from flax) has a strong ecological profile when grown in Europe: it is predominantly rain-fed, requires little or no pesticide, and yields a strong, durable fibre. In practice, linen is not widely used in contract furniture textile. A perception of crease-proneness and a somewhat informal aesthetic has kept it at the margins of the market, a reputation that does not fully reflect the material's actual performance. Its end-of-life position is good: as a mono-material, linen is biodegradable and, if kept clean and unblended, suitable for mechanical recycling.

Hemp shares linen's ecological advantages and adds a high yield per hectare with minimal inputs. The practical barrier is the fibre itself: hemp is stiff, and processing it into a weavable yarn without heavy chemical treatment is technically demanding. European sourcing infrastructure remains limited. Hemp is an ecologically promising fibre with real processing constraints that have not yet been resolved at scale.

For plant-based fibres, the impact is front-loaded: the agricultural phase dominates. What happens after the fabric leaves the loom can either compound or partially offset that upstream footprint.

Fibres: wool (from sheep, goats, alpaca and other animals)

Animal-based fibres carry a different impact profile from plant fibres. The farming phase still dominates, but the categories are different: greenhouse gas emissions, land use, animal welfare, and the water and chemical intensity of fibre processing.

Sheep’s wool is the most used animal fibre in contract upholstery. Sheep produce methane through enteric fermentation, a greenhouse gas with a high short-term warming potential, and wool production requires a lot of land. Wool scouring (washing raw fleece to remove lanolin and impurities) is water and energy intensive, and dyeing adds a further chemical load.

Wool sourced from intensive, large-scale farming carries a heavier footprint than wool from smaller-scale, extensively managed flocks. This distinction is not always visible on a specification sheet, but it is real and consequential. Two certification standards address part of this: the Responsible Wool Standard (RWS) covers land management and animal welfare, including a prohibition on mulesing; GOTS (Global Organic Textile Standard) covers both fibre production and processing, including wet processing and dyeing. A short explanation of both is given in Chapter 9. If a specification sheet lists wool without any certification, it is worth asking about farming practices and country of origin.

Against these production-phase impacts, wool has a lot of advantages elsewhere in the chain. It is durable in use, which extends service life. Wool is biodegradable. And established mechanical recycling routes exist for wool: the fibre can be processed back into yarn without chemical reprocessing, producing a shorter but usable staple. When wool is sorted by colour before recycling, the recovered fibre can often be used without dyeing, saving huge amounts of water, energy and chemicals. The viability of the recycling route depends on how the fabric is constructed and whether it has been backed or blended with materials that complicate separation.

The environmental profile of wool as described here (production-phase impact, biodegradability and established recycling routes) is also relevant for reading LCA comparisons between wool and synthetic fibres. Chapter 12 addresses the methodological questions that arise when lifecycle assessments of natural and synthetic fibres are placed side by side.

ETS in practice. Dutch wool and Dutch linen

ETS often works with wool and linen sourced in the Netherlands. Dutch wool comes from sheep breeds suited to the Dutch climate and landscape, raised on smaller-scale farms. Dutch linen is grown from flax, which, due to global temperatures rising, grows well even in the North of the Netherlands. Both fibres are processed into yarn by European spinners.

Working with local raw materials shortens the supply chain and makes origin easier to verify. It also connects the fabric to agricultural land and farming practices that are subject to European regulatory frameworks. For ETS, sourcing Dutch wool and linen is part of the broader commitment to keeping production and supply chains within Europe, from fibre to finished fabric.

Group 2:

Animal-based

fibres



Fibres: viscose, lyocell, modal, chemically recycled cellulose

Regenerated cellulosic fibres are made from wood pulp or other plant-based cellulose, dissolved into a liquid state and extruded into fibre. Their production is chemically intensive, and the environmental quality of the result depends heavily on the process used.

Viscose (also called rayon) uses carbon disulphide as its primary solvent, a toxic substance that is difficult to contain fully in a closed-loop process. Water use is high. The quality of wood sourcing matters for both viscose and lyocell: if the pulp comes from forest areas without certification (PEFC or FSC), there is a deforestation risk. Viscose can carry a natural perception that its production process does not fully support.

Lyocell uses a different solvent in a closed-loop process that recovers more than 99% of the solvent for reuse. Its production profile is much better than viscose: the closed loop limits chemical discharge, and the process is less water-intensive. It is biodegradable. Lyocell is the benchmark for regenerated cellulose in a circular context.

Modal sits between the two in process intensity, depending on the producer.

Regenerated cellulosic fibres are not common in contract upholstery for office environments.

Chemically recycled cellulose is an emerging category that deserves separate mention. Chemical recycling of cotton converts post-consumer cotton waste into a new cellulosic fibre through a dissolution and extrusion process comparable to lyocell production. The resulting fibre has similar properties to virgin lyocell and does not require the agricultural footprint of a new crop. This technology is being developed at regional scale in the Netherlands and elsewhere, and it represents a potential future route for closing the loop on cotton textile waste. It is not yet available at industrial scale. See Chapter 7 for the current state of this development.



Group 3:

Regenerated

cellulosic fibres

Group 4:

Fossil-based

synthetic fibres

Fibres: polyester (PET), nylon (polyamide), acrylic

Synthetic fibres are derived from fossil raw materials. Their environmental impact is concentrated in the production phase (energy use and fossil resource extraction) and in the use phase through microplastic shedding during washing. End-of-life varies between fibre types.

These fibres are often grouped under “synthetic” on technical datasheets without further elaboration. That grouping obscures real differences in impact and recyclability.

Polyester (PES) is the most widely used synthetic fibre globally. The label “polyester” covers a family of fibre types; PET (polyethylene terephthalate) is the most common in textiles, but PTT (polytrimethylene terephthalate) and PBT (polybutylene terephthalate) also exist. This matters at end of life: different polyester types are not always compatible in the same recycling stream.

Production of all polyester types requires fossil feedstocks and generates a substantial carbon footprint at the manufacturing stage. In use, polyester sheds microplastic particles when washed: fine synthetic fibres that pass through wastewater systems and accumulate in aquatic environments. Polyester is durable and highly abrasion-resistant, which extends service life. As a mono-material, PET is recyclable: mechanically (which shortens polymer chains and somewhat degrades quality) or chemically through depolymerisation (which restores monomer quality but is not yet widely available at scale). Recycled polyester is covered under Group 5.

Nylon (polyamide) requires more energy to produce than polyester and, in some production routes, generates nitrous oxide (N₂O), a greenhouse gas with a global warming potential roughly 270 times that of CO₂ over a 100-year period (IPCC, 2021). Not all nylon production involves high N₂O emissions; it depends on the specific

process route for the precursor chemicals. In use, nylon also sheds microplastics. It is generally more abrasion-resistant than polyester in demanding applications. Like polyester, it is recyclable as a mono-material, with established chemical recycling routes for some nylon types.

Acrylic (polyacrylonitrile, PAN) presents the most challenging end-of-life profile of the three. Unlike polyester and nylon, acrylic is not a standard thermoplastic: it degrades before it melts, which makes melt-spinning recycling impossible. Mechanical recycling through garnetting or shredding is technically feasible, but the resulting fibres are very short, often pre-dyed, and of limited usability in new textiles; this is not a functional fibre-to-fibre circular route. Chemical recycling of acrylic is an active area of research but has no established commercial route as of 2025 (European Commission CORDIS, n.d.). Acrylic also sheds a high volume of microplastics during washing. In a circular purchasing context, acrylic is the fibre with the fewest viable end-of-life options among the synthetic group.

There are many differences between these three fibre types. A fabric described as “synthetic” may contain any of them, or a blend. Ask specifically which synthetic fibre a fabric contains and whether it is virgin or recycled.



Group 4:

Recycled fibres



Fibres: recycled polyester (rPET), recycled wool, recycled cotton

Recycled is not a fibre category: it is a description of origin. A recycled fibre comes from material that has already been processed once. What that means for quality, impact, and end of life depends on which fibre it is, where the material came from, and how it was processed.

Two distinctions apply to all recycled fibres:

Pre-consumer versus post-consumer: pre-consumer recycled material comes from production waste (offcuts, yarn waste, manufacturing rejects) and is generally more consistent in quality and easier to trace. Post-consumer material comes from products collected after use, which introduces variability in contamination, fibre length and composition. An exception applies to certain post-consumer streams such as workwear: when large volumes of the same garment type are returned at end of contract, the consistency of composition can approach that of pre-consumer material.

Mechanical versus chemical recycling: mechanical recycling shreds or pulls apart the material into fibre, shortening staple length and degrading some material properties. Chemical recycling breaks the material down to its molecular components, allowing regeneration at original quality, but chemical recycling is not yet available at scale for most fibre types.

Recycled polyester is the most widely produced recycled synthetic fibre globally, accounting for approximately 8.9 million tonnes in 2023, far ahead of any other recycled synthetic (Textile Exchange, 2024). It can be produced from post-consumer plastic bottles (bottle-to-fibre) or from post-consumer textile waste (textile-to-textile). The carbon footprint reduction compared to virgin polyester is high, with estimates ranging from 30 to 70% depending on the production route and allocation method used. Microplastic shedding during washing remains a factor regardless of origin: recycled polyester sheds at the same rate as virgin polyester.

On the question of source: bottle-to-fibre and textile-to-textile recycling are not equivalent. A plastic bottle has its own established recycling loop; processed back into a bottle, the material stays in a high-value cycle. Converting it into textile fibre removes it from that loop. Textile-to-textile recycling keeps the material within a textile cycle, which is the more circular route for a textile product.

Recycled wool is produced through mechanical processing of post-consumer or post-industrial wool garments and fabrics. The result is a shorter staple fibre than virgin wool, which affects yarn construction and the performance ceiling of the final fabric. The recycling process does not require chemical reprocessing of the fibre itself, which is one of wool's biggest circular advantages. A further benefit: when wool is sorted by colour before recycling, the recovered fibre can be used without dyeing, saving substantial amounts of water, energy and dyestuffs. Established mechanical recycling infrastructure for wool exists across multiple locations in Europe.

Recycled cotton presents the greatest technical challenge. Mechanical recycling produces very short fibres, often too short for standard weaving without blending with longer virgin or synthetic fibres to restore cohesion. Post-consumer cotton is more variable than post-industrial cotton in terms of contamination and composition. Pre-consumer recycled cotton (from manufacturing waste) is generally higher quality and more consistent.

Working with recycled natural fibres is technically more demanding than working with recycled synthetics. Shorter fibres break more easily during weaving and require process adaptations. Achieving target abrasion and pilling values becomes harder as a result.

One consequence that is widely misunderstood: recycled materials are not cheaper than virgin equivalents. They are in fact usually more expensive, because more processing steps are required to clean, sort and prepare the material into a weavable yarn. A price that seems too low for a fabric described as recycled natural fibre is worth examining closely.

The percentage of recycled content in a fabric also matters. A fabric described as "recycled" may contain a small fraction of recycled material, in one component, of one yarn, in one direction of the weave. The claim is technically accurate; its significance depends on the actual share. This is addressed further in Chapter 4.





Commonly used blends

Many upholstery fabrics are not made from a single fibre. Blending serves a specific purpose: combining the strengths of two or more fibres to achieve a performance profile that neither can reach alone.

A few combinations appear frequently in contract upholstery:

Wool and polyester: wool contributes surface quality, resilience and a natural appearance; polyester provides dimensional stability, abrasion resistance and consistent mechanical behaviour under loom tension. It can either be a fibre blend within the yarn, or a construction that uses polyester in the warp, where tensile strength is critical, and wool in the weft, where it determines the surface character of the fabric.

Wool and linen combines two natural fibres with complementary properties. Linen adds body and stiffness to the construction; wool contributes softness and elasticity. The result is a fabric with good structure and a natural surface, suitable for lower-intensity applications. When neither fibre is dyed, the natural colour and gloss differences between wool and linen create a subtle visual contrast in jacquard constructions. A pattern woven from undyed wool and undyed linen reads through texture and sheen rather than colour, producing a tonal appearance without the dyeing load.

Recycled cotton and virgin or recycled polyester is a common route for introducing recycled natural fibre content without sacrificing weaving performance. Recycled cotton fibres are short and variable; blending with polyester restores cohesion and allows the yarn to be processed on standard equipment.

Why 100% recycled is not always achievable

Recycled fibres present technical constraints that make a fully recycled mono-material fabric difficult for many applications. Mechanical recycling shortens fibre length and introduces variability, which in turn reduces tensile strength. Warp yarns in particular must withstand continuous tension during weaving: a yarn that breaks repeatedly in the warp disrupts the whole process. For high-performance woven upholstery, a blend that includes some virgin or higher-quality recycled fibre alongside shorter recycled content is often necessary to reach target abrasion and pilling values.

A fabric with a higher percentage of post-consumer recycled content is making a real contribution; claiming it as a fully recycled product misrepresents the current state of the technology. Chapter 4 gives guidance on recognising this type of claim.

Fibre properties compared



The table below gives a technical reference for the fibres covered in this chapter. Properties vary within each category depending on, for instance, breed, origin, spinning method and processing; the values indicate typical ranges rather than fixed specifications.

Linen and cotton both gain strength when wet, which is relevant for fabrics that will be cleaned with water-based products. Wool loses strength when wet and must be handled accordingly during finishing and cleaning.

Viscose is weakened by moisture, which limits its suitability for applications requiring wet cleaning.

Elasticity differences matter for construction. Wool's high elasticity allows it to recover from compression and distortion over time, which contributes to the long-term appearance of upholstered furniture. Linen's very low elasticity means it holds its shape firmly but does not recover from deformation in the same way.

Fibre	Staple length	Tensile strength (dry)	Strength when wet	Elasticity	Abrasion resistance	Key characteristics
Cotton	10–65 mm	Moderate	Higher than dry	Low	Moderate	Soft, breathable; most commonly used as recycled content
Linen	25–150 mm	High	Higher than dry	Very low	Good	Strong and stiff; ecologically clean when European-grown
Hemp	15–25 mm	High	Higher than dry	Very low	Good	High yield, minimal inputs; EU-grown hemp is difficult to process fully due to fibre stiffness
Wool	40–115 mm	Moderate	Lower than dry	High	Moderate	Resilient and soft; biodegradable; established mechanical recycling infrastructure in the EU
Viscose	38–60 mm	Moderate	Significantly lower than dry	Low	Low	Soft appearance; weakens considerably when wet
Polyester	Continuous / staple	High	Same as dry	Moderate	High	Abrasion-resistant; microplastic risk; recyclable in principle, but textile-to-textile infrastructure still developing
Nylon	Continuous	Very high	Higher than dry	High	Very high	Highest abrasion resistance of synthetic group; microplastic risk





What technical data do not show

The five groups above make clear that the environmental weight of a fabric is rarely where standard technical documentation suggests it is. Weight, Martindale score, and fibre percentage are measurable and comparable. Agricultural impact, processing chemistry, scale of production, and end-of-life routing are not.

Four factors are systematically underweighted in standard procurement assessment:

Local and regional production chains. Where a fibre is grown or raised, and how far it travels before it becomes a fabric, affects its actual impact in ways that a per-kilogram LCA does not capture. Local production is difficult to specify in formal tender requirements, but it is a real variable.

Material savings from made-to-order production. Life cycle assessments calculate impact per metre or per kilogram of fabric produced. They do not account for what is not produced. A weaving mill that produces to order generates less waste fabric and fewer deadstock metres than one operating on forecast-based mass production. That difference does not appear in any standard metric.

Production phase versus end-of-life, and the scale of fibre sourcing. The EU Product Environmental Footprint methodology (PEFCR v3.1, approved June 2025) rates polyester much lower in environmental impact than wool, primarily because of land use and methane emissions from sheep farming, both of which are fully counted in the production phase. What the methodology currently cannot capture is the difference at end of life: wool is biodegradable and has established recycling routes; polyester sheds microplastics that persist in the environment.

Nor does it distinguish between intensive industrial sheep farming and small-scale, extensively managed flocks, which have very different land and climate footprints. The International Wool Textile Organisation has formally documented these gaps (IWTO, n.d.). The methodology itself acknowledges that “other advantages of biodegradability like lower microplastic pollution cannot be considered within the LCA method today since precise impact assessment methodologies are still evolving” (PEFCR, n.d.).

Synthetic versus natural recycled content. Both can be labelled “recycled,” but their impact profiles differ. Recycled polyester and recycled wool are different materials with different production processes, different land use implications during original production, different biodegradability profiles at end of life, and different implications for a fabric’s recyclability. This distinction is rarely asked about in procurement.

Chapter 7



Circular textile, in the full sense of the term, means textile-to-textile recycling: a fabric at the end of its life becomes the raw material for a new fabric of comparable quality. That loop exists in some cases. In most cases, at the moment, it does not because technical feasibility, commercial scale and output quality do not yet align.

A fabric described as “recyclable” may be exactly that: technically recyclable under conditions that are not yet commercially available, in a sorting and collection infrastructure that has not been set up for office upholstery, or through a recycling process that produces a fibre too short for the application it came from. The gap between what is technically conceivable and what is practically available is the subject of this chapter.

This chapter describes four limitations that currently stand between circular ambition and circular practice, and an honest observation of where those limits are moving.

The gap between recyclable and recycled

Mechanical recycling shortens fibres. When a textile product is processed mechanically (for instance shredded, garneted or carded) the fibres break into shorter lengths. Shorter fibres usually result in weaker, less consistent yarns. This is a physical consequence of working with short fibre, not a flaw in the process.

7.1 Fibre length: every cycle has a ceiling.

The consequence is that mechanical recycling typically produces an output of lower quality than the input. For natural fibres, this is the most limiting factor: cotton after one or two mechanical recycling cycles typically produces fibres too short for most woven applications without blending with longer virgin or synthetic fibres. Wool degrades more slowly and leaves more application space for the shortened fibre.

A less obvious finding: woven fabrics yield shorter fibres after mechanical recycling than knitted fabrics. In knitted constructions, yarn loops are longer and more readily separated. In woven constructions, the interlacing of warp and weft creates a more tightly bound structure, and the mechanical recycling process has to work harder to open it, with shorter fibre as a result.

The matters in practice. A thick, dense woven upholstery fabric can yield fibres long enough to be spun back into a similar product. A thin woven shirt fabric typically cannot. Textile-to-textile recycling is not impossible for woven construction types. It depends on the weight, density and fibre type of the specific fabric. It's important to know what the recycled output is used for. A shorter fibre that becomes insulation, padding or a low-pile yarn is still a useful material; it is simply not the same material as what went in.

7.2 Blended fabrics: construction determines recyclability, not percentage.

Whether a blended fabric can be recycled mechanically depends not on what fibres it contains but on how those fibres are physically combined.

A construction in which a thick, softly spun wool yarn with low twist is wrapped with a thin synthetic yarn for structural strength creates a very difficult recycling problem: the fibres are physically entangled in a way that mechanical processing cannot separate. The result is a mixed-fibre output with limited applications.

A blend in which polyester and wool fibres of comparable length are spun together into the same yarn is a different situation. The fibres are mixed, but their similar length means the mechanical recycling output is more uniform and may be suitable for a wider range of uses.

Backing materials, coatings and laminated constructions present the greatest challenge, regardless of the face fabric composition. The difference in fibre length and structure between a backing and the main fabric disrupts the mechanical recycling process, and there is currently no commercial route for separating them before processing. The same applies when fabric has been glued directly to a seat cushion during upholstery: the adhesive layer makes separation from the foam impossible, and the combined material cannot enter a fibre recycling stream.

When assessing the recyclability of a fabric, the focus should not be on just the fibre percentages but the full construction. How are the fibres combined in the yarn? Is there a backing or coating? Has the fabric been glued to another component? What does the recycling input actually look like once the product is at end of life?

7.3 Collection and sorting: pre-consumer is tractable, post-consumer is not.

Even a fabric that is technically recyclable needs to be collected, sorted and delivered to a processor in sufficient volume and quality.

Two very different situations apply here. Pre-consumer collection e.g. recovering production offcuts, end-of-roll fabric and fabric from furniture returned at end of

a leasing contract, is a solvable logistics problem. Volumes are more predictable, materials are known, and the chain from manufacturer to processor is shorter. Collection infrastructure for this stream is being built, and weaving mills and furniture producers that commit to it can make it work.

Post-consumer collection is a lot more difficult. When furniture reaches its end of life in an office environment, it typically enters a general waste stream: a skip, a disposal contractor, a landfill or an incineration plant. The upholstery fabric is not separated from the frame and foam before disposal, and once in the general waste stream, it cannot be recovered for fibre recycling. The key bottleneck is not the recycling technology but the absence of disassembly and separation at the point of disposal.

Consumer textile (clothing) has a growing collection chain in Europe, supported by EU extended producer responsibility legislation for textiles. Contract furniture fabric sits outside most of these streams. Volumes per product are smaller, material composition is more complex, and the logistics are not set up for upholstery.

Near-infrared (NIR) sorting technology can identify fibre types in textile streams and is increasingly available in sorting facilities. It works best on simple, single-component products. Upholstery fabrics with backings, flame retardant treatments and complex multi-fibre constructions are harder to sort reliably by automated systems.

The honest answer to "can this fabric be collected and recycled?" is usually: yes, if a deliberate end-of-life process is agreed before the fabric is installed. Without that agreement, the probability of post-consumer recovery is low.





7.4 Chemical recycling: proven in the lab, not yet at scale

Chemical recycling addresses the limitations of mechanical recycling by dissolving or depolymerising textile material back to its molecular components. The output can be regenerated at original quality, without the fibre length loss that mechanical processing causes. For a genuinely circular loop, where a recycled fabric becomes a new fabric of equivalent quality, chemical recycling is the most credible long-term route.

The current state of commercial-scale chemical recycling of post-consumer textile is limited, and the picture differs by fibre type.

For polyester (PET), depolymerisation technology exists and is operating commercially for bottle streams. Textile-grade feedstock is harder to process: dyes, additives and blended fibres reduce output quality compared to clean bottle-grade PET.

For cotton, dissolution into new cellulosic fibre is the furthest advanced. Several producers have reached demonstration or early commercial scale, though commercial viability remains fragile. One of the leading European producers filed for bankruptcy in 2024 and has since restarted under new ownership; another has shipped its first commercial-scale fibre but has not yet completed a full-scale production facility. A promising initiative in the Netherlands is also working on this route, focusing specifically on post-consumer cotton textile as feedstock. The technology is proven; the business case is still being established.

Enzymatic and chemical routes for wool have been demonstrated at pilot scale, with recovery rates above 80% of protein fibre reported in recent studies. No commercial operation exists.

For most textile streams used in office upholstery, chemical recycling is not yet a route that a procurement decision today can rely on.

7.5. Recycled materials perform differently

Mechanically recycled fibres are shorter and less uniform than virgin fibres. The performance ceiling of a fabric made from recycled natural fibres is, in most construction types, lower than that of an equivalent virgin fabric. This is not a temporary problem that better technology will solve but is a physical consequence of fibre length loss. For mechanical recycling routes, recycled natural fibres structurally cannot match virgin performance, at least not at current process levels.

The question is therefore not whether recycled materials will eventually equal virgin performance, but whether the application actually requires that performance level.

If a procurement requirement specifies 100,000 Martindale cycles for an office chair used by one person at a desk, recycled natural fabrics are automatically excluded. The specification was not calibrated to actual need. A fabric achieving 40,000 cycles is adequate for standard office use. At that threshold, recycled natural materials become viable candidates. The specification, not the material, is the bottleneck (see also Chapter 5).

This applies more broadly. When the performance bar is set by convention rather than by genuine functional requirement, it often excludes exactly the materials that circular procurement is trying to favour.

7.5. Weaving with recycled and natural fibres: what happens on the loom

Recycled and natural fibres perform differently not just in the finished fabric but during the weaving process itself. Understanding those differences helps explain why working with these materials requires specific expertise, and why the results are not always predictable from fibre specifications alone.

Recycled yarn is more variable than virgin yarn. Because recycled fibres are shorter and less uniform in length, the spun yarn tends to break more easily under the tension of the warp. Weaving with recycled yarn requires careful tension management and slower production speeds. Pilling tendency and surface consistency are also harder to control: the shorter fibres have more surface ends, which can migrate to the fabric surface under abrasion and friction. The result is that two fabrics with the same stated recycled content can behave very differently depending on the fibre length distribution and spinning quality of the yarn.

Natural fibres, particularly wool and linen, introduce different processing challenges. Both fibre types shed fine particles during weaving: wool sheds loose surface fibres, linen generates flax dust from the relatively stiff, brittle fibre. This requires good dust extraction and, for linen in particular, controlled humidity during weaving. Linen fibres are sensitive to dry conditions; too low a humidity causes the fibres to become brittle and prone to breaking, while controlled moisture allows the fibre to remain pliable and process more consistently.

These are characteristics that can be managed with the right equipment, conditions and process knowledge. Fabrics made from recycled or natural fibres are more demanding to produce than equivalent synthetic fabrics. That additional complexity has value: it means the fabric has been made with materials that carry a lower environmental load in production and a better end-of-life profile. The cost of working with these materials is part of what makes them what they are.

A close-up photograph of a person's hand, wearing a dark sleeve, touching a large roll of light-colored fabric. The fabric is being processed by machinery, with many vertical threads visible in the background. The scene is set in a textile factory.

Where the limits are moving

The four limitations described above are real, but developments in circular textile have accelerated over the past decade, and two directions stand out.

Chemical recycling is approaching commercial reality for some fibre streams. The technology for cotton, polyester and wool has been demonstrated; what remains is establishing reliable commercial scale. Several producers are in that process now, with cautious but real progress (Textile Exchange, 2024; C&EN, 2026).

Less visibly, pre-treatment methods for textile waste streams are being developed that allow mechanical recycling to recover longer fibres. By treating the material before it enters the defibering process, it is possible to reduce the fibre length loss that mechanical recycling currently causes. This improves the quality ceiling of mechanically recycled textile without requiring a completely new technology base.

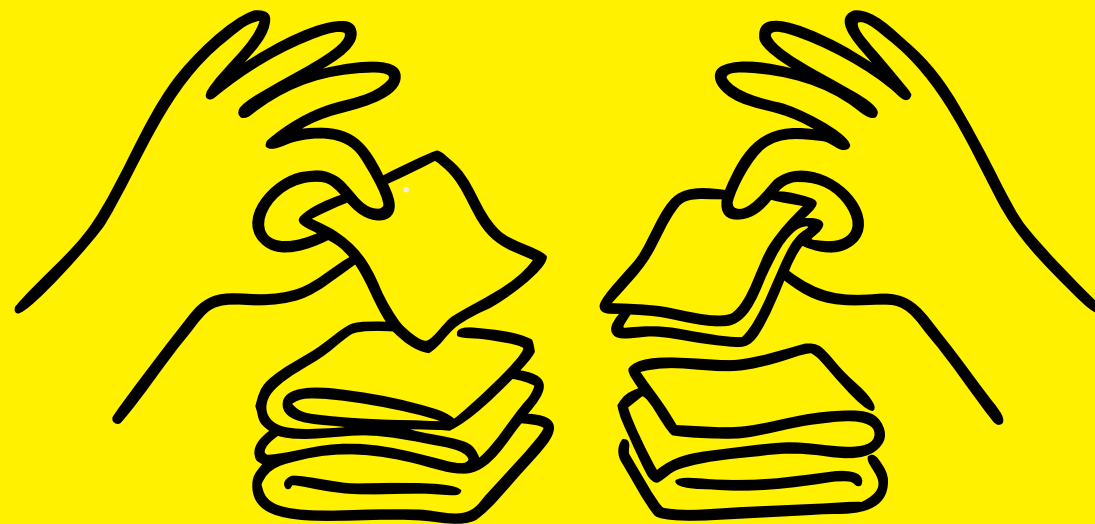
A third direction addresses not recycling but production waste. Conventional upholstery fabric is woven flat and then cut to shape before installation. The cutting process generates offcuts. Multi-layer weaving offers a different approach: by dividing warp threads into groups during weaving, it is possible to create tubular structures or constructions that open and close at defined points on the loom. The resulting fabric can be woven to the approximate form of a furniture component, reducing or eliminating the cut-make-trim steps. First experiments with this technique for upholstery applications are under way in the weaving sector; it is not yet in commercial use for office furniture. The market interest in this direction is there, as well as the potential for waste reduction at the production stage.

For procurement decisions made today, asking “what actually happens to this fabric at the end of its life?” is more revealing than asking whether a fabric is recyclable. Asking specifically about end-of-life routes — the collection chain, the processor, and what the recovered material becomes — gives a more accurate picture than any claim on a datasheet.

Chapter 8

The fibre composition printed on a specification sheet tells you what a fabric is made of. It often tells you little or nothing about what has been done to it since. Finishing covers all treatments a fabric undergoes after weaving. Some are mechanical: calendering, singeing and shearing involve heat and pressure or cutting, but no water or added chemistry.

Others are chemical: dyeing, printing, stain resistance, crease resistance and flame retardancy all introduce substances into or onto the fabric. These treatments are invisible on the final product but can have a direct effect on health, circularity and the value of certifications. A fabric with an excellent fibre profile can become a problematic product through its finishing. This chapter describes the main finishing categories, the substances that require most attention, and what finishing means for end-of-life options.



Finishing — the invisible layer

Dyeing and printing



8.1

Dyeing is the most common chemical finishing step in textile production and carries significant environmental impact: water consumption, energy use and a chemical load from dyes, mordants and auxiliary chemicals. The timing of dyeing in the production chain affects both the result and the impact. Fibres can be dyed before spinning, yarns before weaving, or the finished fabric after construction. Each approach has different consequences for colour fastness, water use and the flexibility of the

8.1 Azo dyes are widely used across fibre types. A subset of azo dyes is restricted under EU REACH legislation because they can release carcinogenic aromatic amines during use or disposal. The restricted substances are listed in REACH Annex XVII; OEKO-TEX Standard 100 tests for these residues in the final product.

Disperse dyes are the primary option for dyeing polyester. They bond less completely with the fibre than reactive dyes do with cotton, which means residual unfixed dye can cause skin sensitisation in direct contact applications. In office upholstery this is a lower risk than in clothing, but the fixation issue also has environmental implications: unfixed dye that enters wastewater treatment is harder to break down.

Digital printing uses less water and produces less chemical waste than traditional screen printing, because dye is applied precisely where it is needed rather than across the full width of a repeat. It has its own chemical profile, however, and does not automatically produce lower residues in the final product.

The most effective approach to the environmental impact of dyeing is to avoid it. Fabrics made in natural, undyed colours or from recycled fibres that carry colour from their previous life require no separate dyeing step. The finishing load is lower, and the environmental impact of that step is absent by design rather than minimised by process.

Relevant standards: GOTS covers the chemistry of dyeing and finishing in certified production. OEKO-TEX Standard 100 sets limits on residues in the final product. ZDHC MRSL addresses restricted substances in the production environment. Each covers a different part of the chain and none substitutes for the others (see Chapter 12).

Functional finishes are applied to improve how a fabric performs in use. Two categories are most relevant for contract upholstery: stain resistance and crease resistance.

Stain resistance

Traditional stain-resistant finishes are based on PFAS: per- and polyfluoroalkyl substances, a family of several thousand synthetic chemicals that resist water, oil and staining effectively. PFAS are also persistent: they do not break down in the environment and accumulate in living organisms. Several PFAS types have been restricted under EU REACH (PFOS and PFOA are listed in REACH Annex XVII), and a broader restriction covering a large portion of the PFAS family is under preparation by ECHA (ECHA, 2023). The direction of regulation is clear.

PFAS-free alternatives exist, including C0 and C2 chemistry, silicone-based treatments and wax finishes. These are not a straightforward solution: performance varies by application, some fall short in demanding conditions, and the alternatives carry their own environmental profiles. None of them is without impact.

There is a third approach: treat the furniture, not the fabric. When a finished piece of upholstery is impregnated rather than the fabric itself, the treatment is applied only to the surface that will actually be in use. Fabric offcuts from the cutting process remain untreated. From a materials perspective this is the more targeted route, and it avoids introducing treatment chemistry into the textile supply chain entirely.

Crease resistance

Traditional crease-resistant finishes are based on formaldehyde-releasing compounds, most commonly DMDHEU (dimethylol dihydroxyethylene urea). Formaldehyde is classified as a human carcinogen. REACH Annex XVII restricts formaldehyde content in textiles above certain concentrations. OEKO-TEX Standard 100 sets limits on formaldehyde residues in the final product, differentiated by product category.

Formaldehyde-free alternatives are available but generally show lower wash durability than formaldehyde-based treatments.



Functional finishes



Flame retardants

8.3

Flame retardancy requirements for contract furniture in almost commonly required in European commercial environments are:

- DIN 4102 B1: the German building materials fire classification, widely applied in German-speaking markets and frequently specified in international tenders
- EN 13773 class 1: the European flammability standard for curtains and drapes, also applied to upholstery fabrics in certain project specifications
- EN 13501-1, B-s1,d0: the European reaction-to-fire classification for construction products, increasingly applied to furniture fabrics in high-specification environments

Meeting these requirements involves either treating the fabric with a flame-retardant finish, selecting fibres with inherent flame-retardant properties, or combining both.

Treated fabrics

Historically, halogenated flame retardants containing chlorine or bromine were the most effective and widely used option. They are persistent in the environment and toxic; most are now restricted or under restriction under REACH and the Stockholm Convention on Persistent Organic Pollutants (UNEP, 2001/ updated 2023).

Modern alternatives include phosphate-based, nitrogen-based (intumescent) and inorganic flame retardants. Each has its own toxicological and environmental profile. Biobased flame-retardant finishes are an emerging development; the chemistry is being refined and tested, but no established standard treatment has yet reached the market at scale.

Inherently flame-retardant fibres

Some fibres carry flame-retardant properties without requiring a separate surface treatment. Wool has a naturally higher limiting oxygen

index than most synthetics and typically meets the requirements of EN 1021-1 (the cigarette ignition test). In practice, however, wool without additional treatment often falls short of the heavier requirements of the contract market, including EN 1021-2 (the match test) and the standards listed above.

An alternative is FR polyester, in which flame retardancy is incorporated into the fibre during manufacturing rather than applied as a surface coating. The absence of a surface treatment layer reduces one type of finishing impact. The flame-retardant substance is still present, however, embedded within the polymer itself. This has implications for end of life: while there is no separate layer to disrupt mechanical recycling, the FR component is part of the material and remains in the recycled output. For chemical recycling routes, the modified polymer structure may also add complexity. Inherently FR fibres are not a clean-sheet solution, but they do avoid the particular problem of a surface treatment that can contaminate a recycling stream.

Finishing versus fibre choice

A fabric that achieves flame retardancy through an applied surface treatment carries that treatment through its service life and into any downstream recycling process. A fabric made from an inherently flame-retardant fibre avoids the surface layer, but the flame-retardant substance is still part of the material. Where specification requirements allow, the inherently FR route reduces one layer of complexity, but it does not make a fabric straightforwardly circular.

8.4. How finishing affects end-of-life

Finishing treatments follow a fabric through its entire life. At end of life, they enter the recycling stream.

Coatings and laminated constructions disrupt mechanical recycling by introducing a second material that cannot be separated before defibering. Flame-retardant surface treatments can contaminate mechanically recycled output and pose inhalation risks when treated fibres are processed in recycling facilities. PFAS-based stain treatments are persistent and do not leave the material during mechanical processing.

This creates a gap in the certification landscape. OEKO-TEX Standard 100 sets limits on harmful residues in the final product, which matters for the end user. The Global Recycled Standard and Recycled Claim Standard certify the recycled origin of material, not its chemical treatment. Neither standard addresses what finishing does to a fabric's recyclability. A fabric can carry both certifications and still be difficult to recycle because of its finishing.

When looking at the impact of finishing processes, both sustainability and durability deserve attention. A synthetic resin applied to a fabric surface can improve pilling resistance and abrasion durability, extending product lifespan considerably. If the resin is applied within a certified chemistry framework (such as OEKO-TEX Standard 100), it is not a health risk in use, but it does carry its own environmental footprint. The question is whether the durability gain justifies that impact: a product that lasts a lot longer with a treatment may have a lower overall impact than one that degrades faster without it. That calculation depends on the specific fabric, the specific treatment and the actual use context.

What the fibre composition on a datasheet does not tell you is what finishing the fabric has received. Asking that question directly is the most useful step a buyer can take.

8.5. Fibre shedding in use Clothing, primarily releases synthetic microplastics into the environment in the washing process. Each wash cycle releases fibres that pass through wastewater treatment and enter waterways and soil. Since upholstery is less frequently washed than garments, the main release of microplastics takes place through abrasion during use. Synthetic fabrics subject to repeated mechanical contact shed microparticles over time. The quantity depends on fibre type, yarn construction and the nature of the contact, but the release occurs in the indoor environment rather than via wastewater. Research into airborne synthetic fibres indoors is ongoing; upholstery surfaces are one potential source among several (RIVM, 2021).

This distinction matters for specification. A

fabric's microplastics profile in use is not the same as its profile in washing. And a preference for natural fibres, which shed organic particles that biodegrade rather than persist, is indirectly also a microplastics choice, even if it is not framed that way.

The EU restriction on intentionally added microplastics under REACH (in force from October 2023) addresses substances deliberately incorporated into products, not incidental fibre shedding. Abrasion-related release falls under ongoing regulatory attention but is not yet covered by the same framework.

8.6. What to ask about finishing

No single certification covers finishing completely. Different standards address different parts of the chain:

- OEKO-TEX Standard 100 tests for harmful residues in the final product. It tells you that what reaches the end user is within defined limits; it does not specify what chemistry was used in production. (OEKO-TEX, 2024)
- GOTS (Global Organic Textile Standard) covers the production process including finishing, and requires that only approved chemistry is used. It applies to organic natural fibres only. (GOTS, 2023)
- bluesign certifies the production environment, including water management and restricted substances in the manufacturing process. (bluesign, 2024)
- ZDHC MRSL (Manufacturing Restricted Substances List) sets out substances that should not be present in the production process. It addresses the factory, not the product. (ZDHC, n.d.)

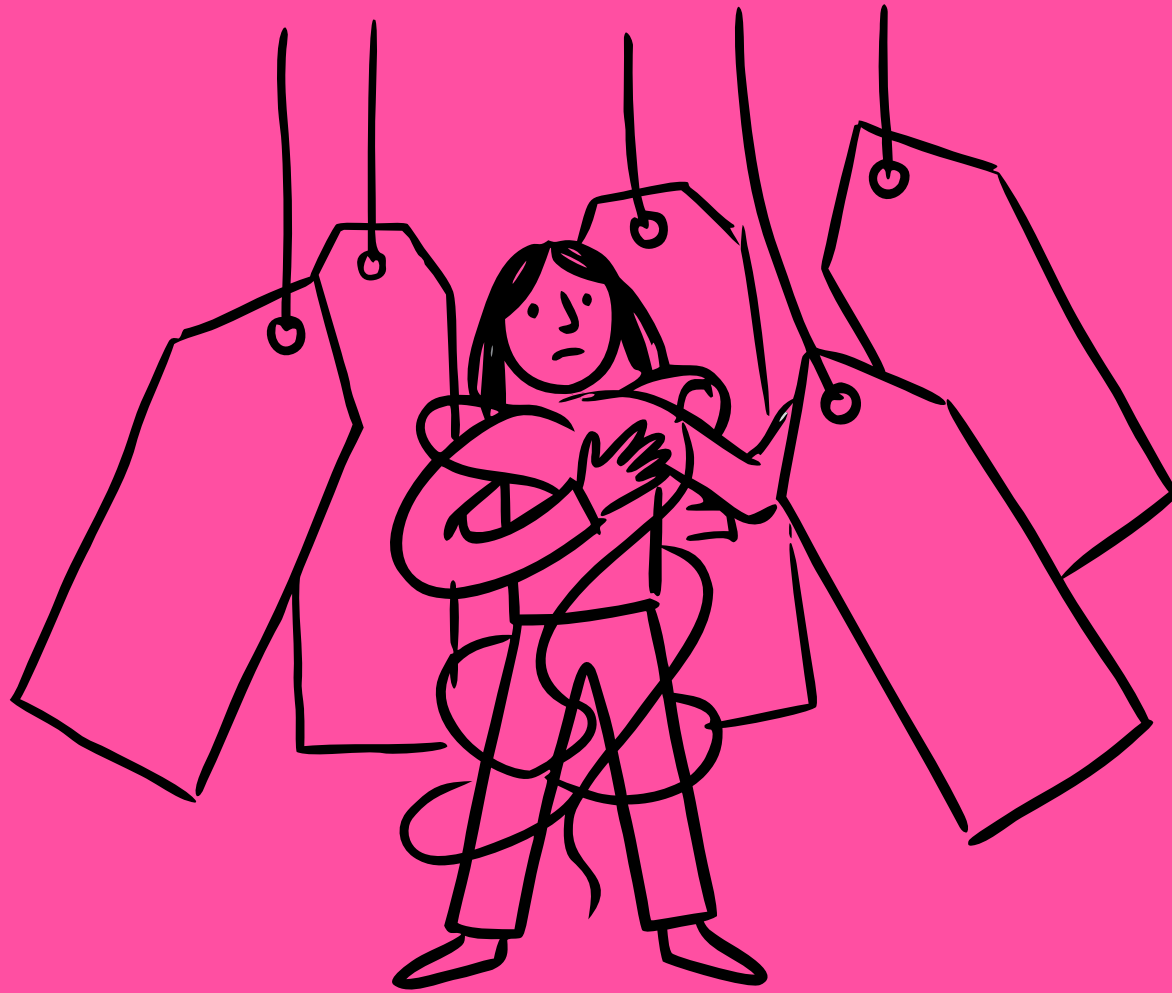
REACH is not a certification but EU law. It sets binding restrictions on specific substances in textiles sold in the European market, including certain azo dyes, formaldehyde concentrations and listed PFAS. Compliance with REACH is a legal minimum, not a quality indicator, and does not substitute for voluntary certification.

Some questions to ask a supplier about finishing: Has any finishing been applied to this fabric? If so, what type: stain resistance, crease resistance, flame retardancy, coating, or other? Does the stain-resistant finish contain PFAS? Does the crease-resistant finish contain formaldehyde? If flame retardancy is present: is it achieved through an applied treatment or through inherently flame-retardant fibres? What does the finishing mean for end-of-life options?

A supplier who cannot answer these questions is a supplier whose finishing is not documented. That is itself useful information.



Chapter 9



A certification on a textile product is not a guarantee that the product is sustainable. It is a guarantee that specific aspects of that product have been assessed by an independent party: the aspects that the certification was designed to address. Which aspects those are, how thoroughly they are assessed, and across which part of the supply chain: that can differ a lot between certifications. Understanding what a certification covers is the prerequisite for using it well.

This matters in practice. Buyers who treat any certification as a general quality signal are working with incomplete information. A fabric can carry a respected label and still have been treated with restricted chemistry, sourced from uncertified farms, or produced in conditions that no auditor has visited. A certification is a precise instrument. It needs to be read precisely.

Certifications — what do they actually cover?

Three types of certification



9.1

Textile certifications assess, broadly, three different aspects of a textile product.

What is in the final product. Residue-based certifications test the fabric as delivered to the buyer for the presence of harmful substances. They address the end result, not the process or the origin of the raw material.

How it was produced. Process certifications set requirements for the production chain: the chemistry permitted, the water management, the working conditions. They do not necessarily test the final product for residues.

Where the raw material came from. Origin certifications trace the source of the material: whether it is recycled, organically grown, or responsibly farmed. They certify the upstream supply chain. Most do not address what happens to the material during manufacturing.

Most misunderstandings in the certification landscape arise when a buyer uses a certification of one type as evidence for something that requires a different type.

9.2

What is in the product: OEKO-TEX Standard 100 and EU Ecolabel

OEKO-TEX Standard 100 is the most widely used consumer-facing label in the textile industry. It tests for the presence of harmful substances in the final product: heavy metals, pesticides, formaldehyde residues, restricted azo dyes, PFAS residues and others. The standard has four product classes, ranging from class 1 (baby and infant textiles, strictest limits) to class 4 (decorative materials, less strict). Testing is carried out by independently accredited OEKO-TEX institutes, and certification is renewed annually (OEKO-TEX, 2024).

What OEKO-TEX Standard 100 does not cover: the production environment, the chemistry used during manufacturing that does not remain in the final product, or the origin of the fibres. A fabric can carry OEKO-TEX Standard 100 certification and have been produced using chemistry that is restricted in other frameworks, as long as the residues in the finished product fall below the limits set by the standard.

EU Ecolabel for textiles sets criteria across fibre production, dyeing and finishing (restricted substances) and product durability. It is managed by national competent bodies under EU oversight and is less common in contract textiles than in consumer goods, but it is the only EU-regulated label in this category (European Commission, 2014).

9.3. How it was produced: GOTS, bluesign and ZDHC

GOTS (Global Organic Textile Standard) covers the full production chain for textiles made from certified organic natural fibres: cotton, wool, linen, and others with organic certification. Requirements apply at every stage: fibre, spinning, weaving, dyeing and finishing. To carry the GOTS “organic” label, a product must contain at least 95% certified organic fibres. To carry the “made with organic” label, at least 70% is required (GOTS, 2023).

GOTS does not apply to synthetic fibres or to recycled fibres. Recycled natural fibres do not count as organic under GOTS and fall into the “other fibres” category, which is capped at 5% for the full organic label and 30% for “made with organic.” This means a blend of GOTS-certified organic fibres with recycled natural fibres cannot be GOTS certified, even if the material choices reflect a genuine sustainability ambition. It is a structural gap that currently works against innovative blends that combine organic and recycled content.

bluesign certifies manufacturing facilities rather than products. The focus is on resource efficiency, chemical safety and water management at the factory level. Fabrics produced at bluesign-certified facilities can carry the bluesign PRODUCT label. bluesign does not certify fibre origin (bluesign, 2024).

ZDHC (Zero Discharge of Hazardous Chemicals) is a coalition of brands, chemical suppliers and other industry participants. Its Manufacturing Restricted Substances List (MRSL) defines substances that should not be used in the production process. Suppliers can demonstrate conformance at three levels (Foundational, Progressive, Aspirational). ZDHC is not a consumer-facing product certification, but it is relevant for buyers who want to assess the chemistry used in manufacturing (ZDHC, n.d.).

9.4. Where the raw material came from: GRS, RCS, RWS, OCS and cotton-specific standards

GRS (Global Recycled Standard) and RCS (Recycled Claim Standard), both managed by Textile Exchange, certify the recycled origin of material. GRS additionally requires chain-of-custody certification and sets minimum social and environmental requirements for production facilities. RCS is simpler: it certifies recycled content without additional production requirements. Neither standard addresses the chemistry used in manufacturing or what happens to the material at end of life (Textile Exchange, 2023).

RWS (Responsible Wool Standard), also managed by Textile Exchange, certifies animal welfare (based on the five freedoms framework) and land management at the farm level, with chain-of-custody traceability through to the final product. RWS covers the farm and the chain of custody; it does not set requirements for spinning, weaving or finishing. A fabric carrying RWS certification may have received finishing treatments that the certification does not address, because RWS scope ends at the farm gate.

OCS (Organic Content Standard) certifies the presence of organically grown material in a product, without the broader production requirements of GOTS. It is a lighter certification focused on origin, not process.

Better Cotton (formerly Better Cotton Initiative) is a widely used standard for more sustainably grown cotton, with a focus on reducing chemical and water use and improving farmer livelihoods. An important limitation: Better Cotton uses a mass balance system rather than physical traceability. A fabric sold as containing Better Cotton is not necessarily made from the specific bales a certified farmer produced; the buyer’s purchase financially supports the Better Cotton system, but the physical fibre in the product may not be traceable to a certified farm. This is an important distinction that the standard is transparent about, but that is rarely communicated at the product level.

Cotton made in Africa (CmiA) is a standard for cotton grown by smallholder farmers in sub-Saharan Africa. It addresses farming practices and farmer livelihoods and also operates on a mass balance basis.

Fairtrade certifies fair pricing and minimum social standards for farmers and workers at the origin of production. For textiles, Fairtrade Cotton is the most relevant application. It addresses the farming stage and farmer income; it does not set requirements for spinning, weaving, dyeing or finishing.

9.5 Company-level certification: B Corp

B Corp is a company certification, not a product certification. It assesses the overall social and environmental performance of a business across five categories: governance, workers, community, environment and customers. Certification is managed by B Lab and requires a minimum score in the B Impact Assessment (B Lab, 2024).

The distinction between B Corp and generic product certifications matters: B Corp says something about how a company operates, not about a specific product or production process.

The scoring framework has consequences that buyers should understand. Activities such as supporting minority communities in lower-income countries contribute to the community score. Companies that produce locally, without international supply chains, cannot score on those criteria: not because their approach is less responsible, but because the framework was designed around a different production model. The maximum score is structurally more accessible to companies with global operations than to those deliberately working at local scale.

9.6. What no certification covers

Several gaps are rarely named in how certifications are presented.

Recyclability at end of life. No certification, including GRS and RCS, guarantees that a product can actually be recycled at the end of its service life. Certification addresses origin or production,





Finishing applied after the certified stage. Whether a certification covers finishing depends on the certification. GOTS covers dyeing and finishing as part of its full-chain scope. RWS, by contrast, covers only the farm and chain of custody: a fabric made from RWS-certified wool may have received finishing treatments that RWS does not address. For any certification, the question is which stages of the supply chain it audits.

Chemical treatments that leave no residue. OEKO-TEX Standard 100 measures what remains in the final product. Chemistry used in production that does not persist in the fabric after processing is not captured by residue testing. Process certifications address this gap; product residue certifications do not.

Working conditions in uncertified links. Most certifications set social requirements only in the links they cover. A supply chain with one certified and several uncertified production steps provides limited assurance about conditions across the full chain.

9.7. A note on audit depth and self-declaration

Not all labels carry the same level of independent verification.

Third-party certified labels, including GOTS, OEKO-TEX Standard 100, GRS and Cradle to Cradle, are assessed by independent certification bodies that conduct audits against defined criteria. The certificate number is verifiable in a public database maintained by the certification body.

First-party or self-declared claims, where a producer states compliance with a standard or benchmark without external audit, are legally permissible but not independently verified. They carry a different level of assurance.

Industry initiatives such as ZDHC operate between these two positions: the standard is collectively developed and maintained, but conformance verification varies in depth and is not carried out by an independent accreditation body.

When a certification claim cannot be verified by certificate number in a public registry, that is relevant information.

9.8. Certifications and the production model they assume

Certification systems are built around a particular production model: standardised collections, repeating production runs, and supply chains that can be audited at each stage. For producers working in made-to-order or small-batch models, where each product is different and production volumes do not follow predictable patterns, existing certification frameworks fit poorly. The audit infrastructure and the cost structure of certification favour scale.

When certifications are required in procurement, they function as a threshold that companies operating at scale

can more easily clear. New business models built on agility, customisation and local production face disadvantages in certification-heavy procurement processes: not because their products are less responsible, but because the certification system was not designed for them.

This is worth naming as a reality, not as an argument against certifications. Independent verification of claims has value. The question is whether the current framework captures the full range of responsible production, or whether it selects for a particular type of producer.

9.9. Beyond certifications: LCAs and the Digital Product Passport

Certifications are not the only tool for transparency. Life cycle assessments (LCAs) provide a quantified picture of the environmental impact of a product across its full life cycle, from raw material to end of life. They are not certifications, and they are not standardised in the way certifications are, but they can provide information that no label currently captures. The integration of LCA data into this guide is discussed further in the relevant chapter.

The Digital Product Passport (DPP), being introduced under the EU's Ecodesign for Sustainable Products Regulation (ESPR), will require products to carry structured data about their material composition, production conditions, repairability and end-of-life routes. When fully implemented, it will provide a layer of transparency that goes beyond what current certifications cover. The regulatory timeline and implications for procurement are discussed in Chapter 10.

9.10. What to ask

Some questions to verify a certification claim:
Which certification, and which version? When was it issued, and when does it expire? Which part of the supply chain does it cover? Which certification body issued it, and is the certificate number verifiable in a public registry? What does this certification not cover?
And one broader question: does the absence of a certification mean the absence of responsible practice, or does it mean the production model does not fit the certification framework?
A supplier without certifications who can answer clearly and specifically what chemistry was used, where the fibre came from and what happens at end of life is providing more useful information than a certified supplier who cannot explain what the certification covers.

Chapter 10

Four EU legislative trajectories are currently in motion that directly affect the procurement of sustainable office textiles. None of them is yet fully in force for contract upholstery fabrics, but the direction is clear and the timelines are becoming concrete. This chapter describes each trajectory, indicates what already applies and what is still being prepared, and explains what a procurement professional should know now — even where legislation is not yet fully implemented.



**EU
regulation
— what is
changing**



10.1

ESPR and the Digital Product Passport The Ecodesign for Sustainable Products Regulation (ESPR, Regulation (EU) 2024/1781) entered into force in July 2024. It replaces the old Ecodesign Directive, which was limited to energy-related products, with a framework that can set product-specific requirements for virtually any product category via delegated acts. Textiles are identified as a priority category.

The product-specific requirements for textiles are still being developed. The European Commission has published a work programme; requirements for textile products are expected to address minimum durability, recyclability thresholds, restrictions on hazardous substances and minimum recycled content. The exact thresholds and timelines will be established in delegated acts, which are in preparation.

The Digital Product Passport (DPP) is a central component of the ESPR. It will require producers and importers to make structured product information available digitally, via a QR code or similar carrier. For textiles, the DPP is expected to include: fibre composition, country of production, care instructions, reparability information, end-of-life guidance, and potentially environmental footprint data. The specific data requirements for textiles are still being defined; pilot projects are running across the sector.

The DPP represents a shift in how product transparency works. Where certifications cover specific aspects of a product or process (see Chapter 9), the DPP will make a broader set of product data accessible to buyers, users and recyclers throughout the product's life. For procurement, this means that the information a buyer currently has to ask for directly, such as fibre composition, finishing treatments, end-of-life options, may in time be required to be available as a matter of law.

The demand for this kind of transparency is already present in the market. Buyers are asking for it before the regulation requires it, and producers across the contract furniture sector are beginning to prepare.

10.2 Extended producer responsibility for textiles

The revised Waste Framework Directive (Directive 2008/98/EC, revised 2018) required EU member states to establish extended producer responsibility (EPR) schemes for textiles by 1 January 2025. EPR means that producers and importers of textile products contribute to a collective system that finances the collection, sorting and recycling of end-of-life textiles.

France was the first to implement. The French EPR scheme for textiles (managed by Refashion, formerly TLC) has been operational since 2022 and covers clothing, household textiles and footwear.

In the Netherlands, the UPV textiel (Uitgebreide Producentenverantwoordelijkheid textiel) has been in force since 1 July 2023. Its scope covers clothing and a specific category of household textiles: table linen, bed linen and household linen (such as tea towels and cleaning cloths). Curtains, upholstery fabrics and carpets are explicitly outside the current scope. For contract office upholstery, this means there is currently no EPR obligation in the Netherlands. Two trajectories may change this:

The EU is preparing an expansion of textile EPR scope that would include woontextiel (home and interior textiles, which could encompass upholstery fabrics). This expansion is expected to enter Dutch law around 2028.

A separate furniture-specific UPV is also under development. A preliminary government study (Voorverkenning UPV meubels, published February 2024 by Rijksoverheid) has been completed, with a targeted implementation around 2030.

One of the consequences for procurement today: upholstery fabrics are not yet subject to EPR in the Netherlands, but this is expected to change within the current planning horizon of most organisations. Procurement decisions made now about furniture and upholstery may be affected by EPR obligations before the furniture reaches end of life.

10.3 Anti-greenwashing regulation

The EU has two parallel legislative trajectories addressing misleading environmental claims.

The Directive on Empowering Consumers for the Green Transition (EmpCo, Directive (EU) 2024/825) was adopted in 2024 and requires member states to transpose it into national law by 2026. It bans: Vague environmental claims (“sustainable”, “green”, “eco-friendly”, “climate neutral”) without substantiation Claims based on carbon offsetting that imply climate neutrality for the product

Claims about the organisation as a whole that apply only to a specific aspect of its operations

The Green Claims Directive (proposed in 2023, still under negotiation as of 2026) goes further. It would require environmental claims to be verified and approved by an independent third party before they can be used in marketing. If adopted in its current form, this will have significant implications for how textile products are described and marketed across the supply chain.

For procurement, the consequence is already present. Suppliers making claims that will not be permitted under EmpCo, or that would not survive scrutiny under the proposed Green Claims Directive, represent a compliance risk. The bar for what counts as substantiation is rising.

This creates a challenge for producers whose transparency depends on detailed knowledge of their own processes rather than on third-party certification. Certification has become the dominant form of substantiation in the market, but it is not the only legitimate form. A producer who can provide specific, verifiable data about fibre origin, production chemistry and end-of-life options is providing substantiated claims, even without a certification label. The challenge is developing the formats and data infrastructure to make that substantiation communicable and verifiable (see also Chapter 9 on the relationship between certifications and the production models they assume).

10.4. Supply chain due diligence

Two broader EU legislative trajectories have indirect but growing implications for textile procurement.

The Corporate Sustainability Reporting Directive (CSRD, Directive (EU) 2022/2464) requires large companies to report on their sustainability performance according to the European Sustainability Reporting Standards (ESRS). Companies supplying to large organisations subject to CSRD will increasingly be asked to provide data on the environmental and social impact of their products. This data request flows down the supply chain: a furniture manufacturer reporting under CSRD needs information from its fabric suppliers; the fabric supplier needs information from its yarn and fibre suppliers.

The Corporate Sustainability Due Diligence Directive (CS3D, Directive (EU) 2024/1760) requires large companies to conduct due diligence on human rights and environmental risks across their supply chains, and to take action where risks are identified. Suppliers to large affected companies will be subject to increasingly structured due diligence enquiries.

Both directives currently apply primarily to large enterprises, but their effects propagate through supply chains to smaller suppliers. A small or medium-sized textile producer supplying to a large furniture manufacturer or a public-sector buyer is likely to encounter these requirements through its customers before it is directly subject to them.

5. What this means for procurement now

The legislative landscape is moving in one direction: more mandatory transparency, more producer responsibility, and higher standards for environmental claims. None of the trajectories described above is yet complete for contract office upholstery, but procurement decisions made today will be in use when many of them come into force.

Practical steps a procurement professional can take now:

Ask suppliers about their Digital Product Passport preparation. Is structured product data already available? If not, how is it being developed? A supplier who has thought about this is better positioned to meet future requirements than one who has not.

Ask about the EPR position of the products being procured. Does this product fall under an existing EPR scheme? If not, does the supplier have a view on how end-of-life responsibility will be structured when EPR expands? Understanding who will bear the cost of end-of-life handling is relevant to the total cost of a procurement decision.

Scrutinise environmental claims against the EmpCo standard. Is the claim specific and substantiated? Does it refer to a verified aspect of the product, or to a general aspiration? Claims that cannot be substantiated with specific data are a compliance risk for the supplier and an information gap for the buyer.

Look for suppliers who can provide data rather than only labels. A producer who documents fibre origin, production chemistry and end-of-life options transparently is providing the kind of information that the regulatory direction is moving toward requiring, regardless of whether they currently hold certifications.

Chapter 11



Recycling is one of the most commonly discussed end-of-life solutions for textiles, and one of the most misunderstood. In the circular economy hierarchy, recycling is a late-stage option: it comes into play when a product can no longer serve its function and its material needs to be recovered. Everything that happens before that point, keeping the product in use longer, repairing it, reupholstering it, passing it on, preserves more value and requires less energy and material input.

This matters for how circularity is evaluated at the point of purchase. A fabric that is technically recyclable but replaced after three years might be less circular in practice than a fabric that cannot be recycled but remains in use for twelve. The metric that matters is not recyclability in the abstract but total material value preserved over time.

This chapter describes the full circularity ladder for office upholstery, from design choices that extend product life to the hierarchy of end-of-life options. Chapter 7 addressed the technical limits of recycling specifically. This chapter addresses what comes before it.

Circularity beyond recycling



The circular hierarchy

11.1 Circular economy thinking places end-of-life options in a hierarchy based on the value they preserve and the impact they avoid. The foundational principle, established in EU waste policy since the 1970s and codified in the EU Waste Framework Directive (Directive 2008/98/EC), is that prevention is preferable to reuse, reuse to recycling, recycling to energy recovery, and energy recovery to disposal. This sequence is sometimes called the Lansink Ladder, after the Dutch parliamentarian who first proposed the hierarchy in 1979.

For office upholstery, the sequence runs approximately as follows, from highest to lowest value:

1. Continued use: the product stays in service, unchanged
2. Repair: a damaged or worn component is fixed; the rest continues
3. Reupholstering: the furniture frame continues; the fabric is replaced
4. Reuse of fabric: the fabric is removed and used for a different purpose
5. Mechanical recycling: the fabric is defibred and reprocessed into new fibre
6. Chemical recycling: the fabric is broken down to molecular components and regenerated
7. Composting: for natural fibres without problematic finishing, as a biological end-of-life option
8. Energy recovery: combustion with heat or electricity recovery
9. Landfill: to be avoided

For natural fibres, composting and anaerobic digestion represent a biological end-of-life route. Material that was grown from the land can, under the right conditions, return to it. This only applies where the fibre is free of persistent chemicals and synthetic coatings.

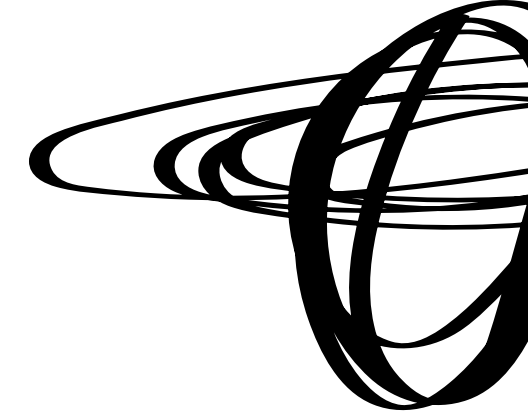
For synthetic fibres, the preferred route is keeping material in the technical cycle for as long as possible, through reuse, refurbishment and recycling, without releasing it into the biological system.

ETS in practice. Reuse at the design stage

A client approached ETS asking whether workwear jackets with an incorrect logo could be mechanically recycled into new fabric. ETS declined, and suggested a different route: an atelier could sew patches over the incorrect logo. The jacket stayed in its original form, at its original quality, without entering a recycling process.

The advice that came with it: avoid printing dates on workwear. A jacket without a date can stay in circulation for as long as it functions. The most circular intervention in this case was not a recycling solution. It was a design recommendation that removes a built-in end-of-life trigger before the next batch is produced.

Lifespan as the strongest lever



11.2 The environmental impact of a textile product is concentrated in the production phase. Growing or producing the fibre, processing it into yarn, weaving it and finishing it accounts for the large majority of the product's lifetime energy use, water consumption and chemical load. Once a fabric is in use, each additional year spreads that initial investment over a longer period (European Environment Agency, 2022).

This makes lifespan the most powerful variable available at the point of procurement. A fabric that remains in service much longer than its replacement would have reduces the number of production cycles required, and with it the cumulative environmental load.

It also reframes how durability specifications should be read.

How durability specifications are written is part of the lifespan calculation. The 100,000 Martindale benchmark has become standard in contract upholstery it's become a threshold that reflects what synthetic fabrics can achieve, not what most office environments require. A specification calibrated to actual use rather than to a material's ceiling opens the field to natural and recycled materials that would outlast the replacement cycle by a significant margin, even at lower scores (see Chapters 5 and 7).

A further consideration: Martindale measures the point at which two threads break. It does not capture visual degradation, the gradual loss of surface quality, pile, colour depth and texture that makes a fabric look worn long before it technically fails. A fabric that reaches 100,000 Martindale but shows visible wear after 20,000 cycles in use may be less suitable in practice than one scoring 40,000 that retains its appearance throughout. Specifying only for thread-break resistance produces an incomplete picture of how a fabric will perform over time (see also Chapter 5).

The main question for any specification is not "what is the highest Martindale value available?" but "what does this space actually require, and which materials meet that requirement?"

Mono-material design and recyclability

A fabric made from a single fibre type, without backing, coating or laminate, is the most straightforward to recycle at end of life. It enters a mechanical recycling stream without requiring separation, and the recovered fibre is more consistent in quality than output from a mixed-material input.

A blend that combines properties unavailable in a single fibre, such as the structural strength of a synthetic with the surface quality of a natural fibre, may outperform a mono-material alternative on durability. If that blend lasts substantially longer in the specific application, the circularity calculation may favour it, even though it is harder to recycle at end of life. A mono-material fabric that needs replacing more frequently is not automatically more circular than a blend that stays in use.

Choosing the right fabric means weighing durability, recyclability, aesthetics and maintenance requirements against the specific project and its actual conditions of use.

Design for disassembly is a related but distinct approach. Where mono-material design optimises the fabric itself for end-of-life processing, design for disassembly optimises the furniture system so that individual components, fabric, foam and frame, can be cleanly separated and replaced without damage to the rest. This extends the life of the furniture independently of any single material’s durability. The Circular Furniture Design Guide produced within the CEO project (WOOD.BE, 2025) addresses design for disassembly in furniture construction in detail.

Repair, reupholstering and service models

Reupholstering, replacing a worn or damaged fabric while retaining the furniture frame, is one of the most effective circularity strategies available for office upholstery. The frame represents the majority of the material and energy investment in a piece of furniture. Keeping it in use while replacing only the surface that has worn extends the life of the whole without requiring a full replacement cycle.

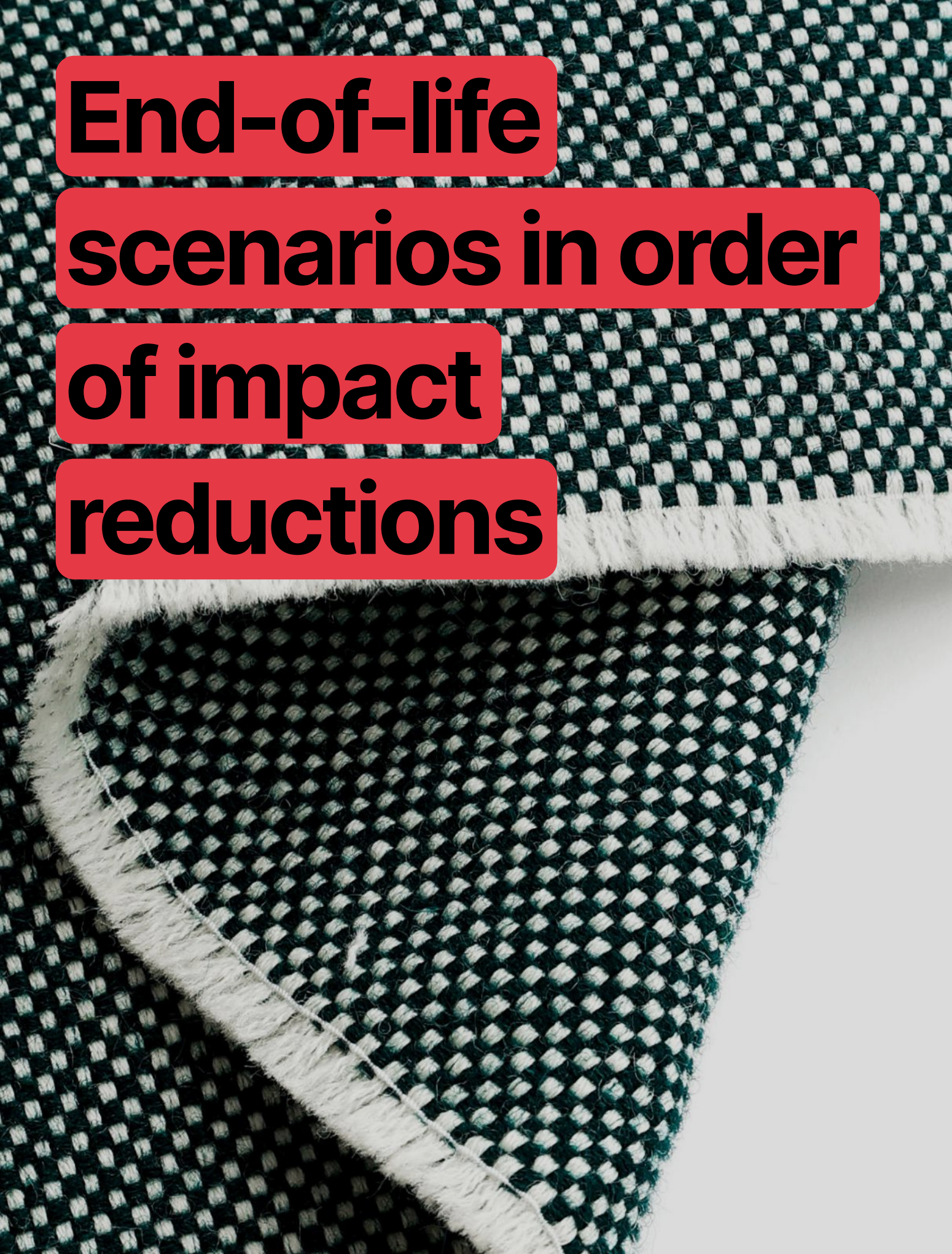
For reupholstering to be a realistic option in practice, two conditions need to be in place. The furniture must be designed for disassembly: the fabric needs to be removable without damaging the frame or the underlying materials, and individual components, foam, webbing and fixing systems, should be replaceable independently. This is a deliberate design choice that not all furniture currently reflects. In lower-cost or fast furniture, reupholstering is often not feasible because the product was not built to allow it. The replacement fabric must also be available, appropriately specified and competitively priced relative to full furniture replacement, which is not always the case.

A further constraint can arise at the installation stage. Bonding fabric to a seat with adhesive makes separation at end of life difficult or impossible: fabric and foam become permanently joined in a way that prevents either from entering a separate recycling stream, and reupholstering becomes impractical without replacing both. Adding a backing, coating or laminate at the point of installation has the same effect: it changes the material composition of the finished product in ways that fall outside the original specification. A specifier who has confirmed end-of-life options at the point of purchase should also confirm the installation method. Processing decisions made at the upholsterer can foreclose options that were available when the fabric left the producer. Design for disassembly matters not only for reupholstering but also for repair and component-level recycling. A frame whose wooden elements, metal parts and foam can be separated cleanly at end of life allows each component to follow its own optimal end-of-life route, rather than entering a mixed waste stream where all routes are compromised.

Take-back and service models build end-of-life responsibility into the supply relationship from the beginning. Rather than selling a fabric as a product, a producer or supplier commits to reclaiming it at end of life, for recycling, reuse or composting, depending on the fibre and finishing. A deposit system, in which part of the product price is returned when the fabric is handed back, creates an incentive for return rather than disposal.

This kind of arrangement requires a longer relationship between supplier and buyer than a standard transaction, and it requires end-of-life planning at the point of procurement: agreeing in advance who collects the fabric, when, under what conditions, and what route it follows.





End-of-life scenarios in order of impact reductions

11.5 The following describes the realistic end-of-life options for office upholstery fabric, from the option that avoids the most impact to the one that avoids the least.

Continued use through resale or donation. If the furniture is still functional and aesthetically acceptable, the whole piece can be resold, donated or transferred to a different use context. No new production is required; no material enters a recycling or disposal stream.

Reupholstering. The frame continues; the fabric is replaced. The most value-preserving option for the fabric itself once its service life is reached, provided the furniture was designed for disassembly and the frame remains structurally sound.

Reuse of fabric. The fabric is removed and repurposed for a different application, such as cushions, bags or acoustic panels. Requires a collection step and a defined reuse route; it cannot be assumed without deliberate planning.

Mechanical recycling. The fabric is defibred into fibre for reuse, typically in lower-grade applications. Fibre quality decreases with each cycle. Requires collection, separation from foam and frame, and delivery to a processor equipped to handle the specific fibre type and construction (see Chapter 7).

Chemical recycling. For certain fibre types, the material can be broken down chemically and regenerated at higher quality than mechanical recycling allows. Infrastructure for most fibre streams relevant to office upholstery remains limited as of 2026 (see Chapter 7).

Composting. For natural fibres free of PFAS, flame-retardant treatments and synthetic coatings, composting or anaerobic digestion is in principle possible. In practice, confirming finishing chemistry and separating from non-compostable components are prerequisites that are rarely in place.

Energy recovery. Combustion with heat or electricity recovery. Lower environmental value than any of the above options, but preferable to landfill. Most office upholstery currently reaches this point.

Landfill. To be avoided.

The gap between the hierarchy as described and the current default, most office upholstery entering general waste streams and ending in incineration, is not primarily a technology gap. It is a planning and infrastructure gap. The options higher in the hierarchy require end-of-life decisions to be made at the point of procurement, not at the point of disposal.

What “circular” on a specification sheet is worth

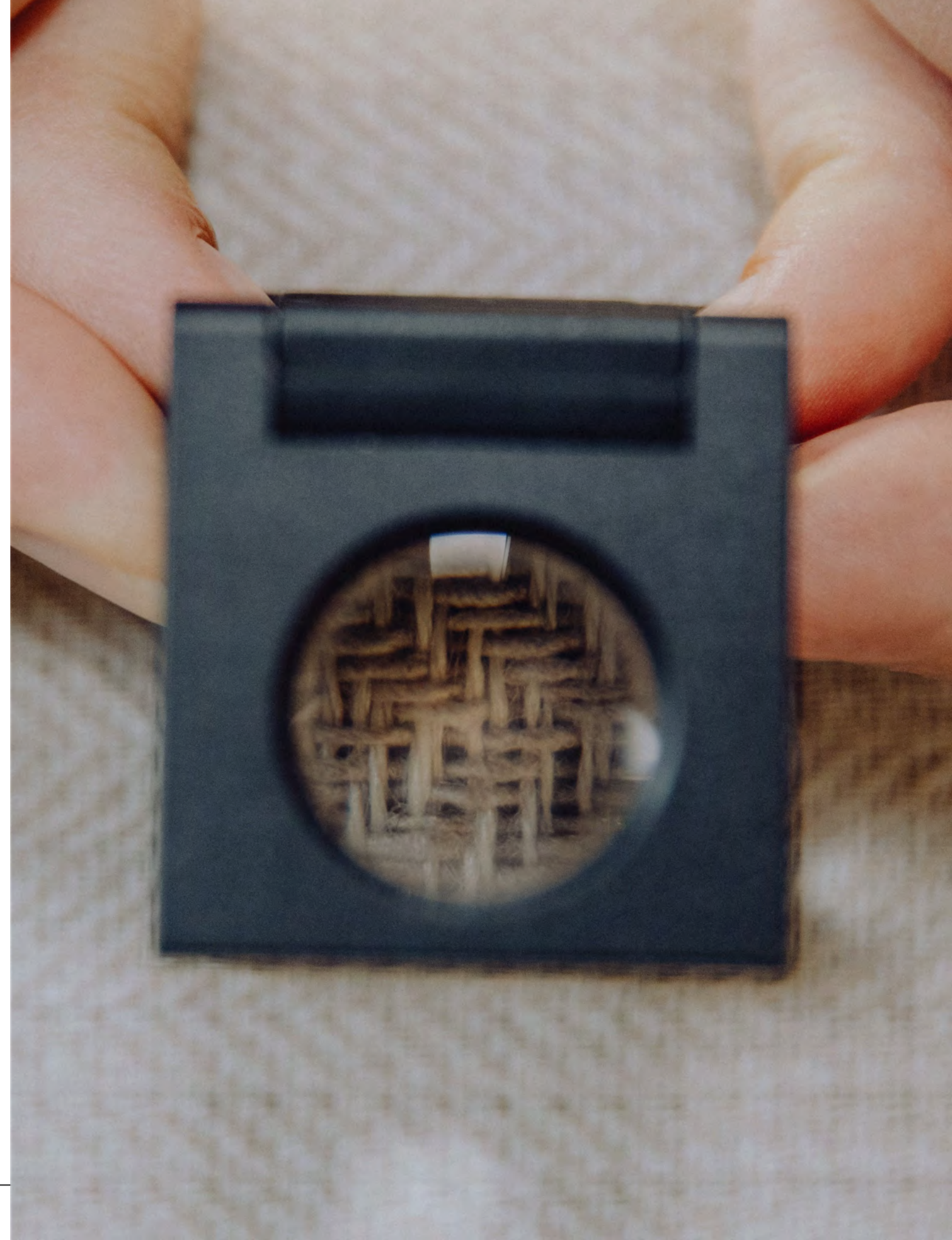
Claims such as “designed for circularity”, “100% recyclable” and “part of a closed loop” appear with increasing frequency on product datasheets and in supplier communications.

“Designed for circularity” can mean that the product was designed with recyclability in mind, mono-material construction, no problematic finishing, or it can mean that someone has considered what might theoretically happen at end of life. The claim is not standardised and cannot be verified without specifics.

“100% recyclable” is technically accurate for almost any textile: any fibre can in principle be recycled under some conditions. It depends though which process, where, under what collection and sorting conditions, and into what output. Without those specifics, the claim is accurate but not informative.

“Part of a closed loop” implies that a specific end-of-life route exists and is operational. This is a stronger claim and, if true, a relevant one. It requires evidence: who is the recycler, what is the process, and where does the recovered material go?

The anti-greenwashing regulation being introduced across the EU (see Chapter 10) will raise the substantiation requirements for these claims. In the meantime, asking for specifics is the most effective filter.



Chapter 12



Life cycle analysis on fabrics and fibers

For the duration of the CEO project Enschede Textielstad has tested many fiber, yarn and weaving pattern combinations in order to determine the best construction for a fabric with the highest possible quality and longest lifespan. Durability is one thing, but a Life Cycle assessment (LCA) can provide science-backed data on environmental impact of a fabric, from raw material to end-of-life scenario.

This chapter briefly describes the LCAs carried out by an independent third party (bAwear) for a selection of upholstery fabrics, explains how to read the results, discusses some flaws in the methodology and explains what the numbers mean for material choices and procurement decisions.

What is an LCA?



A life cycle assessment maps the environmental impact of a product across its full lifecycle: raw material extraction, processing, production, use and end of life. The method is standardised in ISO 14040 and ISO 14044, which define the principles, framework and requirements for conducting and reporting an LCA.

Results are expressed per functional unit, a defined quantity of the product that serves as the reference point for comparison. For textiles, common functional units include per kilogram of fibre, per square metre of finished fabric, or per running metre of cloth.

The most commonly used impact categories for textile LCAs include climate change (expressed as kg CO₂-equivalent), water use (litres or cubic metres), land use (square metres per year), eutrophication (nitrogen and phosphorus emissions), and human toxicity. Each category measures something different. A low climate score says nothing about water use, and vice versa.

For apparel and textile products, the EU Product Environmental Footprint Category Rules (PEFCR) for Apparel and Footwear, currently at version 3.1 (2025), provide the most recent harmonised methodology for calculating and comparing environmental footprints. And lastly an important thing to note: not all LCAs use the same method, which makes cross-study comparisons difficult unless the methodology is explicitly aligned.

How to read LCA results

Before drawing conclusions from an LCA report or summary, four questions are worth asking.

What is the functional unit?

An LCA per kilogram of raw fibre and an LCA per running metre of finished fabric at a specific weight and construction will produce different numbers for the same material. Comparisons between studies are only valid when the functional unit is the same, or when the results have been recalculated to a common basis.

What lifecycle phases are included?

A cradle-to-gate study covers raw material extraction through production but stops at the factory gate. A cradle-to-grave study extends through use and end of life. A cradle-to-cradle or closed-loop study incorporates recycling credits. The scope affects the outcome significantly, particularly for materials where the use phase or end-of-life route has high impact.

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What assumptions were made about end-of-life?

For most textiles, end-of-life scenarios are modelled rather than observed, because the actual route a specific product takes is not known at the time of production. The assumed scenario, whether incineration, landfill, mechanical recycling or composting, can substantially change the result.

Which allocation method was used for recycled content?

The environmental impact of recycled material depends on whether the study uses a cut-off approach, which assigns no burden from the original production to the recycled material, or an end-of-life recycling credit approach, which distributes the burden across cycles. Both are methodologically defensible; the outcomes can differ significantly.

The LCAs for ETS upholstery fabrics



About the study

The LCAs for this chapter were carried out by bAwear, using primary process data provided by ETS rather than industry averages. The system boundary is cradle-to-gate, covering raw material sourcing, spinning, weaving, finishing and transport. Results are expressed per kilogram of finished fabric. The analyzed fabrics range from 330 to 595 grams per square meter, and with an average fabric width of 145 cm this means the chosen unit of 1 KG of fabric is the equivalent of 1,25 to 2 running meters of fabric.

Analytical layers

The study was structured in several analytical layers, each isolating a different variable:

Fibre comparison: construction, weight and all other parameters held constant; only the fibre type varies. This allows a direct comparison of the impact attributable to the raw material choice alone.

ETS fabric constructions: analysis of fabrics as actually produced, with construction included. This reflects real-world impact rather than a theoretical fibre comparison. Compound versus single structures: the difference in impact between layered and single-layer constructions. Yarn counts: the effect of different yarn counts on environmental impact and potential savings.

Blends and compositions: how different fibre combinations compare to single-fibre alternatives.

Finishes: four variants compared, FR treatment, resin treatment, washed only, and no finish. This layer is directly relevant to the discussion of finishing in Chapter 8: it quantifies what a finishing step adds to the overall footprint.

Lifespan (where data allows): how extending the service life of a fabric affects its impact per year of use.

Materials assessed

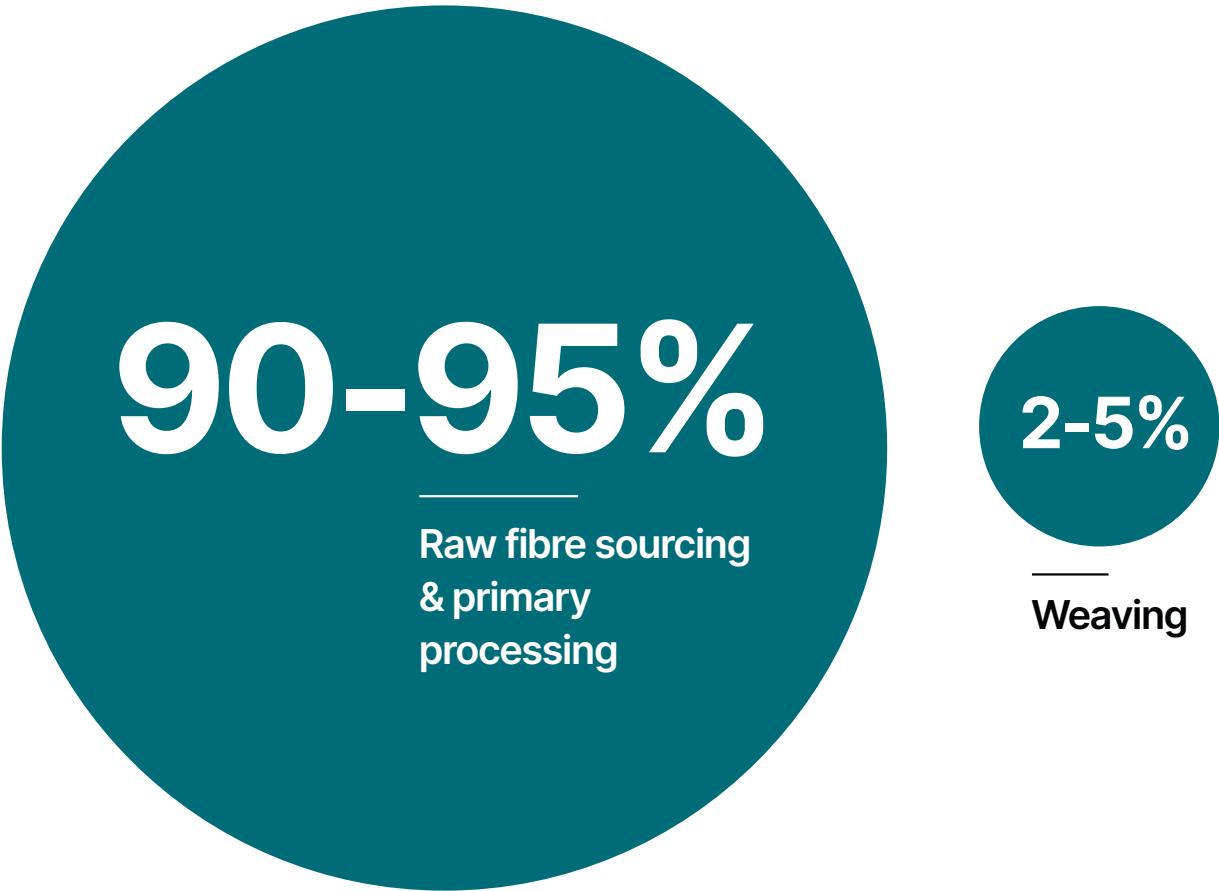
Nine fibre types and blends were included in the analysis:

- Dutch/European wool
- Dutch/European linen
- Recycled cotton
- Recycled wool
- Recycled polyester
- Blend of wool and linen
- Blend of wool and recycled cotton
- Blend of wool and recycled wool
- Blend of wool and recycled polyester

In addition, the analysts prepared a set of benchmark comparisons using hypothetical mono-material constructions. Based on one benchmark fabric with a weight of approximately 462 grams per square meter, woven in a basket weave, they calculated the impact of fabrics with exactly the same construction, weight and other parameters. Only fibre type, production country and dyeing method varied. These comparisons isolate what actually drives the numbers.

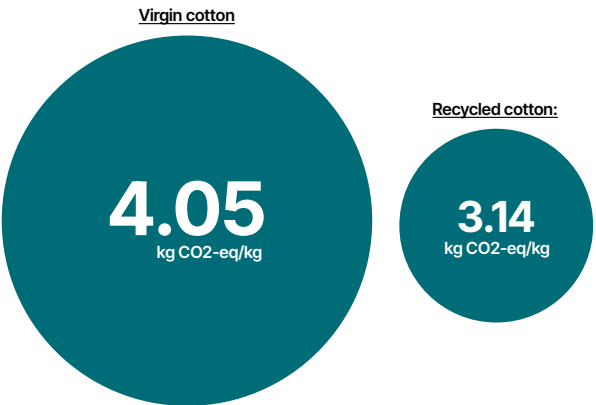
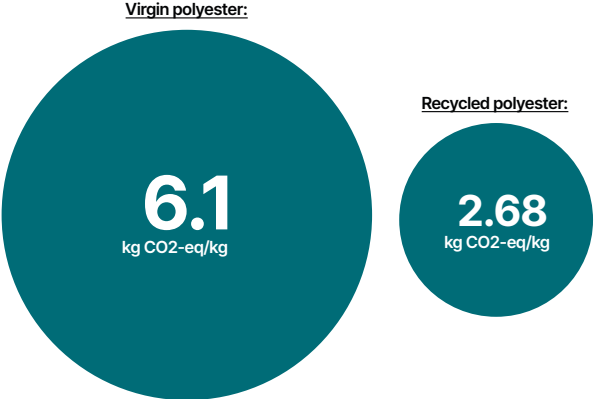
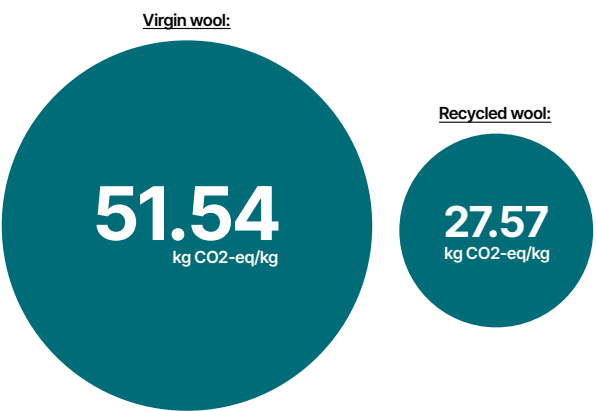
Opting for undyed yarn for our dutch linen reduces the fabrics’s carbon footprint by 220%

The fibre materials stage dominates the footprint
Across all fabrics assessed, raw fibre sourcing and primary processing account for roughly 90 to 95 percent of the calculated global warming impact. The weaving step represents 2 to 5 percent of the total. Dyeing and finishing add a further small share.



47% lower global warming recycled wool vs virgin wool, same construction, NL production, undyed.

Recycled fibre consistently scores better than virgin
For each fibre type assessed alongside a recycled alternative, the recycled option scores 30 to 50 percent lower on global warming, fossil resource scarcity, water use and land use.



The gap between virgin and recycled is largest for wool and polyester. For cotton, the gap is smaller because cotton’s footprint is already relatively low in the NL undyed scenario.

Production country affects multiple stages

The energy mix of the production country affects not just the weaving step but every energy-intensive stage in that country. For example for linen, yarn spinning uses 0.45 kg CO2-eq/kg in the Netherlands compared to 3.92 kg CO2-eq/kg in Asia, which is nearly nine times higher, driven by the fossil-dominated power grid. The weaving step shows the same pattern: 0.38 in the Netherlands against 1.38 in Asia.

Dyeing method and production country are decisive variables

Dyeing can occur at three points in the production chain: at the fibre before spinning (fibre-dyed), at the yarn before weaving (yarn-dyed), or not at all (undyed). Which method is used as well as where dyeing occurs determines which stage of the footprint carries the additional load.

For linen produced in Asia, fibre-dyed production shows a fibre materials cost of 7.56 kg CO2-eq/kg against 1.93 for an undyed equivalent. The dyeing energy is absorbed into the fibre stage. Yarn-dyed production keeps the fibre materials cost at 1.93 but raises the yarn production cost from 1.96 to 3.92. In total, fibre dyeing scores higher than yarn dyeing across all impact categories. Both score substantially higher than undyed production in the Netherlands.

For linen, the range across production scenarios:

- NL, undyed: 3.81 kg CO2-eq/kg
- Asia, yarn dyed: 8.55 kg CO2-eq/kg
- Asia, fibre dyed: 12.21 kg CO2-eq/kg

3.2x higher. Linen fibre-dyed Asia vs linen undyed NL

For polyester, the ratio between fibre-dyed Asia and undyed NL is 2.4 to 1.

Cotton’s water footprint is an outlier

Cotton scores low on global warming compared to wool. Two factors explain this: plant-fibre processing requires less energy than animal-fibre processing, and a significant share of cotton cultivation is rainfed rather than irrigated, which reduces the modelled agricultural water footprint.

Cotton’s high water demand at the agricultural stage, described in Chapter 6, is visible in the LCA numbers:

1,250 L/kg. Water consumption for cotton (NL, undyed), compared to 286 L for wool, 49-68 L for linen and polyester

The ETS benchmark fabric

For the benchmark fabric used in the analysis 3×3 Panama with a wool warp and recycled wool weft, the total global warming score is 39.98 kg CO2-eq per kg. A fabric containing recycled wool alongside virgin wool sits 23% lower than a 100 percent virgin wool equivalent at the same construction and under the same production conditions (produced in NL with renewable energy sources)

Some remarks on the LCA's on wool
Wool scores relatively high on global warming in this study. BaWear recognises this issue:

The same question keeps surfacing in our client work and in public debate: why does wool, a renewable and biodegradable fibre with a long history of recycling, often score worse in a life cycle assessment than virgin fossil-based polyester? The short answer is that an LCA is a model, and current models represent natural and synthetic fibre systems in ways that are not yet aligned.

- Prerana Raidurg

We would like to address three issues we find relevant in this context:

The first is biogenic carbon. Wool stores carbon in the fibre itself during the life of the animal. This sequestration is not consistently captured in current LCA methodology, and data on the biogenic carbon content of wool is limited. Including it would likely improve wool’s climate score, but by how much is not yet established

The second is use phase and end-of-life. This study is cradle-to-gate and does not include what happens to

the fabric after use. For wool, this is important. If wool degrades in poor conditions (landfill without oxygen) it releases methane, which is worse than incineration. But if wool is mechanically recycled, the footprint per use can be distributed across multiple cycles. A fabric recycled four times carries roughly a quarter of the per-use impact of one that is not recycled at all. Neither scenario is reflected in the current scores. We would like to address three issues we find relevant in this context:

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A study of wool sourced from Dutch farms is in preparation. The expected difference compared to the imported wool used in the current study is 5 to 10 kg CO2-eq per kg, based on the supply chain characteristics of locally raised wool: a shorter transport chain, different farming conditions and potentially different land management. The study will also make it possible to compare conventional and biological farming methods, which cannot yet be distinguished in the current data. Results will be added to this chapter when available.

Known gaps in polyester LCA methodology

Polyester scores relatively low on global warming in this study and near zero on land use. Some thoughts on that topic:

The first is land use measurement. The land use category measures crop-equivalent land, which captures agricultural impact but not land used for fossil fuel extraction, refining and infrastructure. Oil and gas extraction, including hydraulic fracturing, occupies land and disturbs ecosystems that do not appear in the score. Polyester's near-zero land use figure reflects this measurement gap, not an absence of land impact.

The second is methane from fossil fuel extraction. Extraction processes, particularly hydraulic fracturing, can release methane as a fugitive emission. Methane is a potent greenhouse gas. These emissions are partially captured in the global warming score, but data quality on fugitive emissions from fossil fuel production is variable and the contribution may be underestimated.

The third is microplastics. Synthetic textiles shed microplastic fibres during use, through washing and mechanical wear and tear. Microplastic pollution is not an impact category in current LCA methodology. The fibres released over the lifespan of a polyester fabric do not appear in any of the scores in this chapter.

For end of life: polyester does not biodegrade. This study ends at the factory gate. A cradle-to-grave assessment would need to account for the persistence of synthetic material in landfill, which is a lasting impact, compared to biodegradable wool.





What the numbers do not say

Biodiversity is absent or only partially represented in most LCA methods. The impact of land use on local ecosystems, soil health and species diversity is not captured in a standard climate or water score.

Animal welfare is not an LCA category. The welfare conditions under which wool or other animal-derived fibres are produced fall entirely outside the scope of a standard environmental LCA.

Local production effects, such as employment, regional economic activity and the social value of a local supply chain are not measured by an environmental LCA.

Production scale is not distinguished in standard LCA data. The method uses representative averages for fibre production, which do not differentiate between fibres sourced from intensive operations and those from small-scale farms. For wool in particular, the environmental profile of a small farm with extensive land management can differ significantly from industrial-scale production in terms of land use, carbon sequestration and biodiversity effects. A general wool LCA score does not tell you which type of farming it represents.

Overproduction is not measured in an LCA. The method calculates impact per unit produced, but says nothing about how many units are produced beyond actual demand. A fabric with a low per-kilogram score that is routinely overproduced and ends up as deadstock carries a real environmental cost that the LCA does not show. For example: if a mill produces ten thousand metres of fabric and sells seven thousand, the true environmental burden per sold metre is roughly forty-three percent higher than the modelled figure, because the unsold three thousand metres carry the same fibre, energy, water and transport. Production on demand avoids that cost entirely, but the benefit is invisible in a per-unit comparison.

Recycling output quality is not reflected in the score. Mechanical recycling of a fabric produces fibre, but the length, consistency and applicability of that fibre depend on the input material and the process. An LCA credit for recycling does not distinguish between high-quality output and low-grade filler material.

Social impacts for instance labour conditions, living wages, health risks during processing, are not part of an environmental LCA. A separate method, Social LCA (sLCA), exists for this purpose, but it is not yet standardised to the same degree and is rarely used in commercial textile assessment. Chapter 15 addresses the social dimension of textile production.

These limits are not arguments against using LCAs. They are arguments for reading them alongside other information, including certifications (Chapter 9), production context (Chapter 13) and the social chapter (Chapter 15).

Using LCA data in a procurement conversation

An LCA report or summary in a supplier’s documentation is a starting point, not a conclusion. As you have read in this chapter, the methodology is not flawless and results can differ greatly between different research methods. The following questions help assess whether the data is meaningful and comparable

Who conducted the LCA, and was it independently verified? An LCA produced internally without external review carries less weight than one audited or verified by a third party. BAWear uses primary data submitted by producers; the quality of the result depends on the accuracy of the input.

What is the functional unit? Before comparing two LCA summaries, confirm that both use the same reference point. Per kilogram and per running metre are not directly comparable without conversion.

What lifecycle phases are included? A cradle-to-gate study is not comparable to a cradle-to-grave study without adjustment. If end-of-life is excluded, the comparison favours materials with high end-of-life impact.

Are the end-of-life assumptions stated? If a study assumes recycling but no recycling infrastructure exists for that fibre and construction in your region, the assumed credit may not materialise in practice.

Are the assumptions transparent? A credible LCA report states its assumptions clearly. If a supplier cannot explain the basis for their environmental score, the score cannot be verified.

The EU anti-greenwashing regulation being phased in across member states (see Chapter 10) will raise the substantiation requirements for environmental claims including LCA-based ones. In the meantime, these questions are the most effective filter available.



Chapter 13

A fabric label tells you where something was woven. It does not tell you where the fibre was grown, where the yarn was spun, or where the cloth was dyed and finished. Those earlier steps are harder to trace. In most life cycle assessments, they account for the largest share of environmental impact. A supply chain that is European across all those stages tells a materially different story from one where only the final weaving step is local.

Production context



Where impact concentrates

A textile supply chain runs through several stages: fibre production, yarn spinning, fabric construction, wet processing, and transport between each step. Life cycle assessments place the bulk of environmental impact in the early stages, specifically fibre production and wet processing.

Fibre production carries most of the land use, water consumption and chemical load. Wet processing, dyeing in particular, is energy and water intensive. Together, these two stages represent the majority of a fabric's carbon footprint, water use and chemical burden across its full lifecycle (European Environment Agency, 2022).

What “local” means in practice

“Locally produced” requires a follow-up question: which part of production is local?

A fabric can be woven in Europe while the fibre comes from Central Asia, the yarn was spun elsewhere, and the dyeing happened in a third country. The weaving step is local. The chain is not. Whether that matters depends on which stages carry the highest impact, and weaving is generally not among them.

Shorter supply chains do offer real advantages, though they are not always the ones buyers expect. Traceability is easier to verify over fewer intermediaries and shorter distances. Overproduction risk decreases when producer and buyer are closer, because shorter lead times reduce the need to produce speculatively. And reliance on air freight is avoided. When speed requires air transport, the carbon cost per tonne-kilometre is roughly fifty to one hundred times higher than sea freight (CE Delft, 2022). Supply chains that depend on air freight carry a materially different transport footprint from those that use sea and road. European supply chains, where goods move by road throughout, avoid intercontinental sea freight entirely, creating a further reduction that does not appear in headline comparisons between air and sea.

When a supplier describes their product as locally or European produced, it is worth asking whether that covers fibre origin, spinning and finishing, or only the final weaving step.

ETS in practice. A European supply chain

A question ETS has asked consistently is how far back the European footprint of its fabrics extends.

For recycled materials, the answer is: fully. Recycled cotton runs from fibre to yarn within the Netherlands. Dutch wool and Dutch linen follow the same path. Recycled wool is sourced from Italian producers.

For virgin fibres, the picture is more varied. Linen yarn is spun in Poland from European flax. All ETS's yarn suppliers spin in their own factories in Europe. Finishing takes place in Germany, using European chemical suppliers. Where origin uncertainty exists, it is in the virgin fibre component of blended yarns; that information will appear in the lifecycle assessment results for those materials.

When sourcing yarns, we value proximity over price. We deliberately source only within the EU: it keeps the supply chain within reach of European labour standards and reduces the likelihood of undocumented steps between producer and loom.

Scale, batch production and made-to-order

High-volume production has a price advantage: larger runs spread fixed process costs across more metres of fabric, which is why it has become the industry standard. The downside is that stock-based supply requires fabric to be produced before orders are confirmed. Unsold inventory is written off as deadstock or, even worse, incinerated.

Made-to-order works differently. Fabric is woven when an order is being placed. No unsold stock accumulates, and the energy, water and material for unneeded fabric is not spent. The downside is a longer lead time: orders need to be produced rather than shipped overnight from a warehouse.

From the weaving mill's side, the direct connection between order and production means each run is defined by a specific project. Construction, colour and quantity are set before the loom starts. There is no existing stock to adjust to, no overrun from last season to work around. What the project requires is what gets made.

ETS in practice. Flexibility as a sustainability choice

ETS holds no stock; we produce on demand and therefore prevent overproduction or deadstock from happening. A further consequence of this model is flexibility in quantity. Customers can combine different colours or specifications within a single order, each at the quantity the project actually requires. The principle: a buyer should not be required to purchase more than the project needs.

This works when both sides accept the logic: less stock, produced on demand, with lead times that reflect actual production rather than warehouse availability. For buyers who plan early enough, that creates a concrete benefit for the full chain.

There is challenge in how made-to-order production fits into the broader market. Many buyers manage their own operations on lean principles: holding as little inventory as possible, ordering close to need. Applied consistently, that principle aligns well with made-to-order supply. In practice, however, lean procurement often coexists with an expectation of immediate availability: the buyer wants low stock but fast delivery, which requires the supplier to hold the buffer instead. When suppliers are expected to maintain large stocks across many product variants to guarantee short delivery times, the inventory has not been eliminated: it has been moved upstream. For producers who do not manufacture speculatively, that expectation is incompatible with how they work. The transition to a lower-waste supply chain eventually requires both sides to accept the same logic: less stock, produced when needed, with lead times that reflect actual production.

The social dimension of production location

European labour law sets standards for wages, working hours, health and safety conditions and worker representation. A producer operating under Dutch, German or Polish law is subject to inspection mechanisms and enforcement that provide a baseline for workers in that part of the supply chain. Extending that principle to the whole chain by sourcing from European spinners, finishers and chemical suppliers, brings the same framework to the earlier steps.

Social conditions in textile supply chains are not uniformly reported or certified. Certifications such as GOTS and Fairtrade include social provisions, but not always all supply chains are certified, and certification does not cover every stage. Choosing suppliers whose production falls under European regulatory frameworks is a sensible approach to prevent social risk, separate from certification.

ETS in practice. Producing against the grain

ETS produces in its own weaving mill in Enschede. That is a choice made against the direction of the market, and it is made deliberately. Producing in the Netherlands means higher wages, higher rent and higher energy costs than producing in Asia or Africa. It also means customers can visit the loom while a new fabric is being developed, without weeks of sample rounds crossing continents. Labour conditions are governed by Dutch law and inspected accordingly. The supply chain stays in Europe: ETS works exclusively with European yarn suppliers, which brings the same legal framework to the earlier steps in the chain. Local production, in this sense, is not only an environmental argument. It is a social one. For organisations assessing supply chains on social criteria, the EU Corporate Sustainability Due Diligence Directive (CS3D, 2024) provides a reference framework. It requires larger European companies to identify and address social risks in their supply chains. The questions it asks are the same ones that responsible procurement has always called for: where is production, under what conditions, and how is that verified?

Collaboration in the chain

Shorter supply chains, made-to-order models and transparent social conditions are more achievable when producers, buyers and intermediaries work from shared frameworks.

Several initiatives in the Netherlands are building those frameworks:

Future>Factory>Furniture (F>F>F) is a collective of Dutch textile and furniture producers, including ETS, working together to develop a circular supply chain of timeless, sustainable products. The focus of this initiative is on improving the supply chains of the four main materials used in furniture: foam, wood, steel and textiles. The initiative operates as a counterweight to the trend toward cheap, fast furniture, and has expanded internationally via Dutch Design Week and Milan Design Week.

TexPlus is a Dutch foundation of 6 regional stakeholders in the circular textile supply chain that supports knowledge development and collaboration across the textile sector, focused on sustainable and circular innovation.

Dutch Circular Textile Valley connects producers, designers and researchers in the Dutch textile region working on circular textile development.

NewTexEco is a research consortium of three educational institutes and over 150 Dutch textile organisations working together on circular chain development, including fibre-to-fibre recycling routes and chain collaboration tools.

Questions worth asking

Production context provides a frame for evaluating supplier claims, not a single answer. A few questions that help:

Where in the supply chain does “local” apply? Fibre origin, spinning and finishing are typically more consequential than the weaving location. A European label on the final step does not describe the full chain.

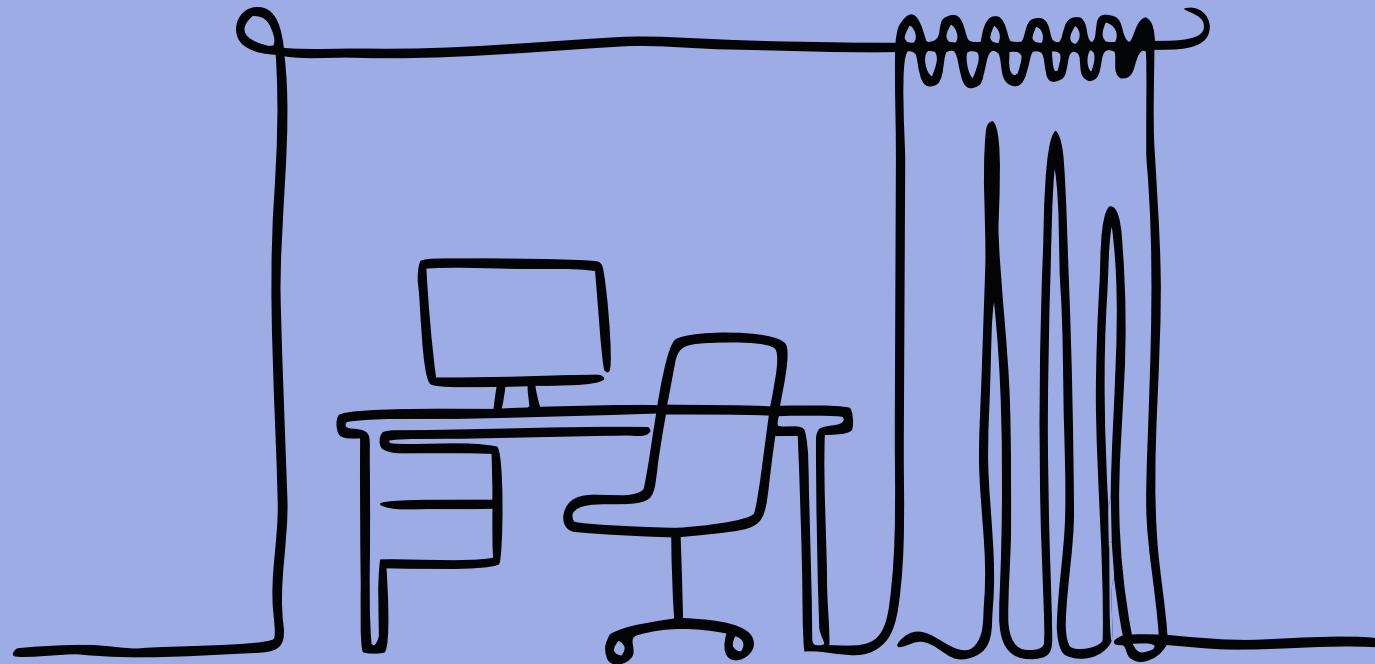
Is environmental performance supported by lifecycle data, or does it rest on production location alone? Location of manufacture is a visible fact. It is not a lifecycle score.

Does a made-to-order or low-MOQ option exist? Ordering closer to actual need reduces surplus. The availability of smaller or more flexible orders is a practical circularity variable, not only a commercial one.

Is production subject to European labour law throughout the supply chain, or only at the final step? Asking which legal framework governs each part of the chain is more informative than asking for a social certification.



Chapter 14

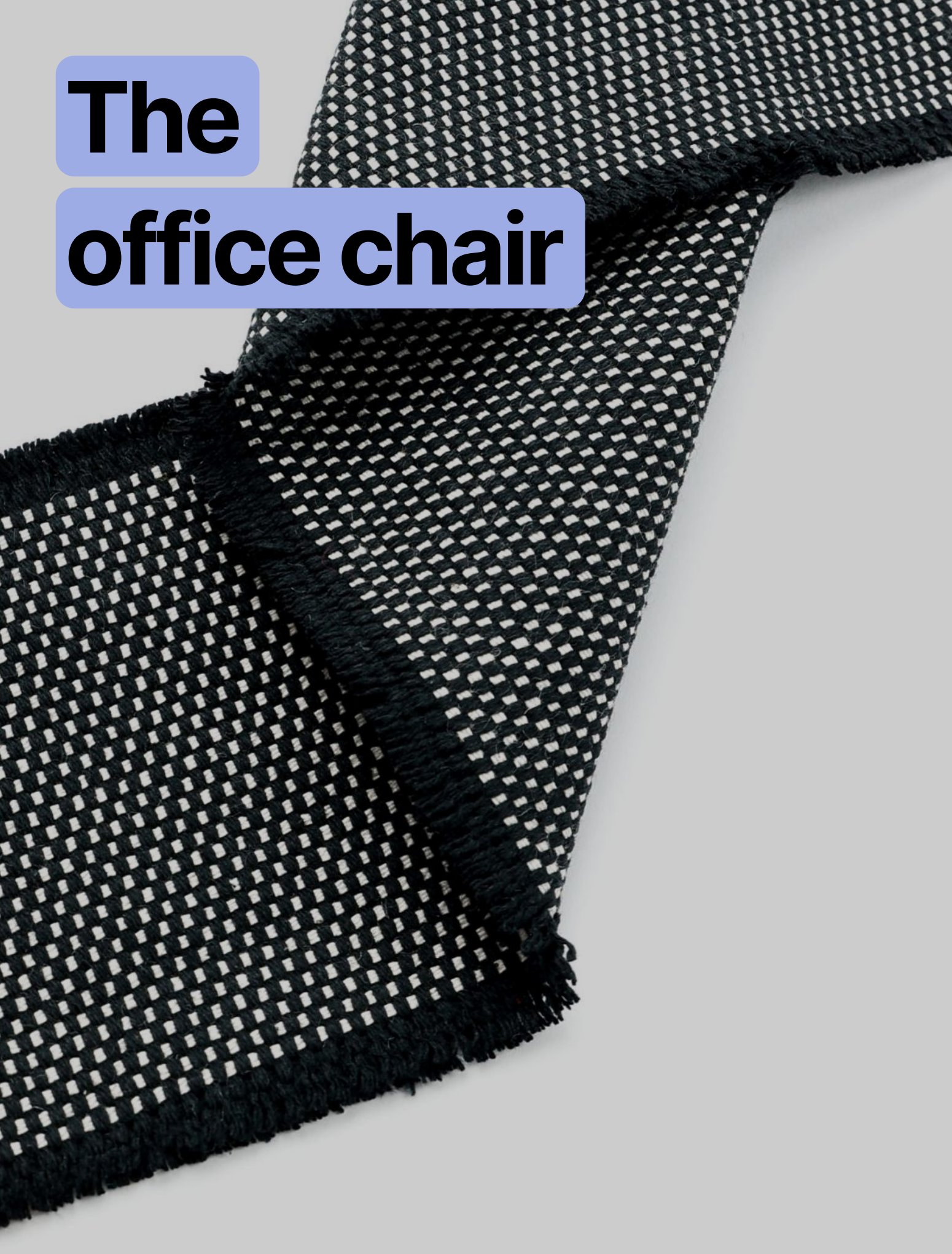


The previous chapters have covered fibres, construction, finishing, certifications and circularity in general terms. This chapter is about specific situations: what does that knowledge mean when a particular piece of furniture needs a fabric?

Two variables influence almost every contract upholstery decision. The first is use intensity: how hard and how often will this furniture be used? The second is how mobile the furniture is: will it stay in one room for its entire life, or is it likely to move between settings, be reupholstered, or find a second user?

Those two variables are not independent. Together they shape which properties matter most and which concessions are worth making.

Applications in practice



The office chair

Intensive use, second life potential

Office chairs take more punishment than almost any other piece of upholstered furniture. Eight hours a day, five days a week, in direct contact with clothing and skin. Friction is constant, perspiration is a factor, and the fabric stretches repeatedly across the seat and backrest as the chair is adjusted and used.

For a fabric to hold up in this context, yarn quality matters more than fibre category. A well-constructed recycled polyester with high yarn regularity and a tight weave performs reliably under these conditions. A natural fibre fabric can too, if the construction is right: dense, with short floats, and spun from long-staple fibre with adequate tensile strength. What does not hold up is a loosely woven fabric with long floats and irregular yarn, regardless of fibre type. The questions from Chapter 5, specifically about yarn count, float length and weave balance, are directly applicable here.

For the office chair it is not just important how long the fabric lasts, but also what happens to the chair afterwards. A modular chair where the upholstery can be removed and replaced has a different end-of-life profile from one where fabric is bonded permanently to foam. If the chair has a strong second market as a refurbished object, the fabric should support that: a timeless colour and texture that reads well outside the specific interior it was first installed in, fabric that can be removed cleanly without damaging the seat shell, and a material that a reupholstery workshop can replace with standard techniques.

This connects to a broader principle sometimes called design for refurbishment. A well-designed office chair is not only built to last; it is built to be repaired. New castors, a replacement armrest, a fresh set of fabric panels: these interventions extend the useful life of a structurally sound chair without requiring full replacement. For this to be possible in practice, suppliers need to offer spare parts and upholstery panels independently, not only as part of a full chair replacement. Some suppliers are moving towards furniture-as-a-service models, where they retain ownership of the chair and take it back for refurbishment at the end of a lease period. In those arrangements, the fabric specification is part of the supplier's own interest in keeping the product in circulation.

The meeting chair

Lower intensity, easier second life

Meeting chairs and lounge armchairs are used less intensively than office chairs, but they are often more visible and more bulky: they require more materials in terms of foam, wood, steel and fabric. They appear in reception areas, client-facing rooms and break-out spaces where aesthetic durability matters alongside physical durability.

The lower mechanical stress means a wider range of constructions are viable. Natural fibres that would wear too quickly under constant seating friction can perform well here. Wool blends, linen fabrics and recycled natural fibre textiles are realistic options where they might not be in a heavy office application.

A standard meeting chair is a commodity object: it moves between rooms, goes into storage, gets replaced in batches, and occasionally finds a buyer on the second-hand market. Specifying a fabric with broad aesthetic appeal and standard removable upholstery construction gives the object the best chance of continued use after the first project ends.

When purchasing a fabric you should not only go for the most sustainable fabric, but also ask yourself: "what makes this specific chair worth reupholstering rather than discarding in five years?" A fabric that still looks coherent, a construction that still holds, and a colour that does not date: these are not decorative preferences. They are the conditions under which furniture continues to circulate rather than accumulate in a skip.

Bespoke meeting furniture



Space-specific, material decisions last

Custom-built meeting configurations, reception lounge installations, corridor seating: these pieces are designed for one room. They will not find a second setting the way a standard chair might. When the space is redesigned, they will most likely be removed and, unless there is an active programme to recover them, discarded.

For space-specific furniture, the circularity question shifts from second life to material recovery. Can the fabric be separated from the foam and frame at end of life? Is the foam certified to a standard that allows reclamation? Are the components assembled in a way that allows disassembly, or bonded together permanently?

The fabric choices here can be less conservative on aesthetics, because broad market appeal is not the goal. What matters more is that the material choices do not block recovery. Fabric bonded to foam creates a composite that is harder to recycle than either material alone. A fabric with a backing bonded during manufacturing may be difficult to separate later. The construction decisions discussed in Chapter 14 are most critical here, because there is no second-life pathway to absorb a poor specification decision.

Use intensity for bespoke pieces varies. A high-traffic corridor installation is not the same as a directors' lounge that sees one meeting a week. Specifying for the actual use pattern, rather than for a generic contract upholstery standard, avoids over-engineering in one direction and under-specifying in another.

Large upholstered elements

Foam, backing and the disassembly

Large sofas, banks of seating, modular sofa configurations: these objects combine substantial foam volume with fabric and structural components. Moving them is impractical, full reupholstery is costly, and disassembly typically requires specialist intervention.

The foam specification matters as much as the fabric. Durable foam that maintains its shape over the expected lifespan avoids premature replacement driven not by fabric wear but by foam collapse. Foam certified to standards that allow reclamation opens recovery pathways that standard PU foam does not.

A large sofa where the fabric is sewn onto removable covers can be reupholstered with standard workshop skills. One where the fabric is glued or permanently bonded to the foam requires either the full cushion to be replaced or the whole piece to be discarded. The specification decision made at purchasing stage determines which of those outcomes is possible.

For fabric selection on large upholstered elements, durability and cleanability are the primary functional criteria. The more consequential question, though, is whether the fabric is part of a construction that allows disassembly. A technically sound fabric on a permanently bonded construction gives no options when the time comes.

Where the two axes meet

High-intensity use shortens the time before a replacement or refurbishment decision is needed. Low mobility reduces the options available when that moment arrives.

The most constrained situation is high-intensity, space-specific furniture: corridor seating, large upholstered elements in public-facing spaces. Durable construction and material recovery options matter most, because neither timeless aesthetics nor easy relocation will extend the life of the object.

The most flexible situation is lower-intensity, mobile furniture: meeting chairs, lounge chairs in spaces that are regularly reconfigured. Broad aesthetic appeal and standard upholstery construction are the practical levers for extending useful life.

Office chairs sit in a category of their own: high intensity, but mobile and with an active second-hand market. Modularity and fabric replaceability are the critical variables.

Closing Section

**The most
circular
textile: an
honest
answer**

This guide serves as a compass for you to make informed decisions when choosing a textile. We deliberately refrained from statements such as 'the best', 'the most sustainable' etc. When asked what the most circular textile for an office environment is, there is no single answer. The most circular textile for an office environment depends on three variables that pull in different directions: the specific use, the priority between durability and end-of-life options, and what actually happens to the fabric when it is replaced.

A fabric used intensively on a high-traffic task chair needs to stay functional for years without replacement. If it does, its environmental investment is spread over a long service life, regardless of fibre type. A fabric replaced every three years, however recyclable, runs that production cycle more frequently than one replaced every ten.

For spaces with moderate use, the calculus shifts. A natural fibre fabric with a lower abrasion threshold may be entirely adequate. It costs less to produce, carries a lower chemical burden, and if uncoated and unblended, has a credible biological or mechanical end-of-life route.

The honest answer to “which fibre is most circular?” is: the one that lasts long enough in the specific application, is specified without unnecessary performance margin, and has an agreed end-of-life route before it is installed. A 100% recycled fabric without a collection plan in place is less circular in practice than a virgin wool fabric with a confirmed take-back arrangement. What this guide has tried to show is not which material to choose, but what questions to ask before choosing. The most circular procurement decision is one made with enough information to match material to use, and use to end of life.



Sources and further reading

CEO project publications

This guide was produced as part of the output of the East Netherlands Pilot of the Circular Economy Office (CEO) project, funded by Interreg North Sea Region (2021–2027). The four main publications of the CEO project are directly relevant for readers who want to go further on circular office furniture.

CEO Manifesto

The manifesto sets out the case for a circular approach to office furniture in Europe: why current models are problematic, what the transition requires, and what the project partners committed to.

<https://www.interregnorthsea.eu/ceo/ceo-manifesto>

Legal Frameworks Guideline

A structured overview of EU regulations that apply to circular office furniture: product requirements, reporting obligations, and upcoming legislation.

<https://www.interregnorthsea.eu/ceo/legal-frameworks-guideline>

Circular Business Models Guideline

Covers circular business model types relevant to office furniture: from product-as-a-service and take-back arrangements to digital tools and barriers to scaling.

<https://www.interregnorthsea.eu/ceo/circular-business-models-guideline>

Circular Furniture Design Guide

A design-oriented guide covering principles of circular design for office furniture, integration of those principles into product development, and technological processes for circular manufacturing. Includes material sheets for wood, steel, foam and lacquer.

<https://www.interregnorthsea.eu/ceo/circular-furniture-design-guide>

All four publications:

<https://www.interregnorthsea.eu/ceo/manifesto-guides>

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Colophon

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